SOIL SURVEY

Kinney County, Texas

ELECTRONIC VERSION

This soil survey is an electronic version of the original printed copy, dated 1992. It has been formatted for electronic delivery. Additional and updated information may be available from the Web Soil Survey. In Web Soil Survey, identify an Area of Interest (AOI) and navigate through the AOI Properties panel to learn what soil data is available.

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1959 to 1961. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1962. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station; it is part of the technical assistance furnished to the West Nueces-Las Moras and Devil's River Soil Conservation Districts.

HOW TO USE THIS SOIL SURVEY

This Soil Survey of Kinney County contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

All the soils of Kinney County are shown on the detailed map at the back of this report. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the report. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, range site, or any other group in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the discussions of capability units, range sites, and wildlife suitability groups.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Use of Soils for Wildlife."

Ranchers and others interested in range can find, under "Use of the Soils as Range," groupings that show suitability of the soils for range, and also the plants that grow on each range site.

Engineers and builders will find, under "Engineering Uses of Soils," tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation, Classification, and Morphology of Soils."

Students, teachers, and others will find information about soils and their management in various parts of the text, depending on their particular interest.

Newcomers in Kinney County may be especially interested in the section "General Soil Map," where broad patterns of soils are described.

Cover picture:—Sheep grazing on Kimbrough soils of Shallow Ridge range site. The brush was controlled before the blue panicum was seeded.

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SOIL SURVEY OF KINNEY COUNTY, TEXAS

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION

Kinney County is in the southwestern part of Texas; it borders Mexico (fig. 1). The county consists of 891,520 acres, or 1,393 square miles. It ranges from gently rolling in the southern part to hilly and broken in the northern. Elevations range from nearly 800 feet in the southwestern and southeastern corners of the county to about 2,200 feet in the northern part.

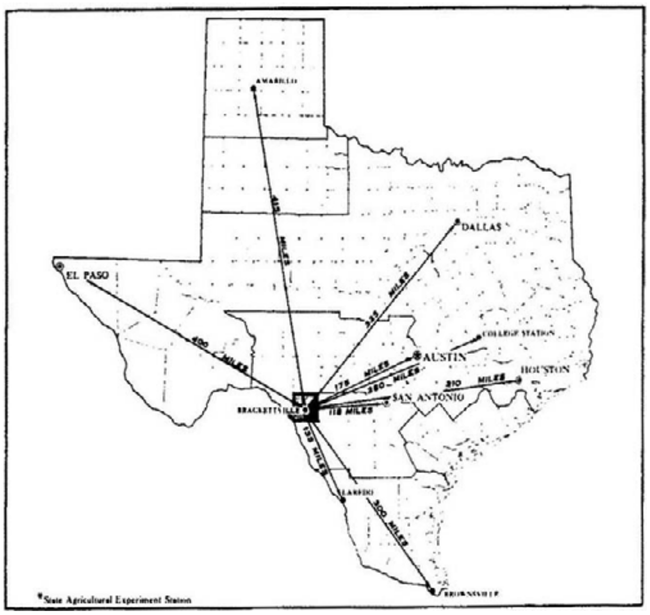

Figure 1.—Location of Kinney County in Texas.

Most of the county is in range, much of which has been overgrazed and is in poor condition. Some areas have been root plowed and seeded to introduced grasses. Sheep, goats, and cattle are the main kinds of livestock. In 1959 there were 93 ranches or farms in the county, and the average size of a ranch was 8,078 acres. Many white-tailed deer and some turkeys and javelinas are found on the rangeland.

In 1959 less than 1 percent of the county, or 2,524 acres, was cultivated. Of this cultivated acreage, 1,989 acres was irrigated. The main crops are grain sorghums, cotton, corn, oats, and vegetables.

The county has many beautiful scenic spots. Brackettville, the county seat, was originally the outgrowth of an army post but has since been used as the location for western movies.

In 1960 the population of Kinney County was 2,452. Brackettville had 1,662 people, and Spofford, the only other town in the county, had 138.

Most of the roads in the county are hard surfaced or graveled, or they have been built on gravelly soils and can be readily traveled in all kinds of weather. The roads in the county include two U.S. highways, one State highway, and seven paved farm and ranch roads. A railroad crosses the county from east to west, and a branch line serves as an entrance to Mexico.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Kinney County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Uvalde and Montell, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series; all the soils having a surface layer of the same texture belong to one soil type. Montell clay is a soil type in the Montell series.

Some soil types vary so much in slope, salinity, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Montell clay, low, is a phase of Montell clay. Because of its low position, it is more saline than Montell clay.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map at the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Kavett-Tarrant stony clays.

Some mapping units contain more than one kind of soil in a pattern more open and less intricate than that of a soil complex. Such a mapping unit is called a soil association. A soil association differs from a soil complex in that its component soils can be mapped separately, at ordinary scales such as 4 inches per mile, if practical advantages make the effort worthwhile. A soil association, like a soil complex, is named for the major soils in it, for example, Jimenez-Zapata association.

Also shown on most soil maps are areas so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Alluvial land, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. On the basis of yield and practice tables and other data the soil scientists set up trial groups, and then test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this report shows, in color, the soil associations in Kinney County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

Four soil associations are in Kinney County. Soil associations 1 and 2 consist of very shallow, gravelly or stony, loamy soils, and soil association 3 consists of deep, loamy and clayey soils. The soils in association 4 are on bottom lands.

1. Kimbrough-Ector-Uvalde association: Dominantly very shallow, gravelly and stony, loamy soils in nearly level to undulating areas

This association, the largest in the county, has an area of about 353,420 acres, or almost 40 percent of the county. It consists of undulating, broad ridges and nearly level, shallow valleys. Slopes range from 0 to 8 percent. The association is mostly in a continuous, broad belt extending from the eastern boundary of the county to the western boundary. From this belt, two smaller areas extend to the southern boundary.

Kimbrough soils make up 50 percent of the association, and Ector soils about 20 percent. The remaining 30 percent consists of the Uvalde, Dev, Knippa, Pintas, Reagan, Quemado, and Ingram soils.

The Kimbrough soils are grayish brown, calcareous, and gravelly. They are about 3 to 10 inches deep over hard caliche. These soils occur mainly in wide, nearly level valleys and in other areas that lie below the Ector soils, but some areas are gently sloping.

The Ector soils are grayish brown, calcareous, and stony. They are about 3 to 12 inches deep over limestone. These soils occur mainly on ridgetops and in the more sloping areas.

The Uvalde soil is friable, dark grayish brown, and calcareous. It has a silty clay loam surface layer and is underlain by caliche at a depth of about 30 inches.

The Quemado are very gravelly soils that are shallow and very shallow over hard caliche. They occur in gravelly alluvium near the Rio Grande. The Dev soils are very gravelly and occur on bottom land along some of the creeks. Ingram are shallow, stony clays that occur on some of the hills such as Las Moras and Pinto. The Uvalde, Frio, Knippa, Pintas, and Reagan soils are deeper than the Ingram soils and are in the valleys and flood plains along creeks.

Most of this association is rangeland and is grazed by sheep, goats, and cattle. The vegetation consists of a moderate cover of grasses and forbs and of thorny brush, including guajillo and mesquite. Guajillo is well liked by sheep and goats. In general, the soils in this association are not suitable for cultivation, but the deep soils are farmed in those areas where irrigation water is available. In some areas caliche and limestone are mined for road material.

2. Tarrant-Ector association: Very shallow, stony, clayey and loamy soils in rolling, hilly, and broken areas

This soil association occupies the northern third of the county and an area that includes the Anacacho Mountains in the southeastern part. These areas total about 325,820 acres, or about 37 percent of the county. The association is rolling, hilly, and broken, and in many places, it is deeply dissected by canyons having vertical walls. In most places slopes range from about 8 to 70 percent, but in a few places, near heads of drainageways, they are about 2 to 8 percent. Slopes range from gently sloping to very steep within short distances. Stones and boulders are common on the surface.

This association is made up of about equal parts of Tarrant soils, and Limestone rockland. Minor soils in the association are the Dev, Frio, and Kavett soils.

The Tarrant soils are very dark grayish brown to black, very shallow, stony clays that overlie hard limestone. They occur in undulating to hilly areas in which rock outcrops and boulders are common. Most areas of the Tarrant soils are in the northeastern part of the county (fig. 2).

The Ector soils are grayish-brown, very shallow stony loams and clay loams that overlie hard limestone. Like the Tarrant soils, Ector soils occur in undulating to hilly areas in which rock outcrops and boulders are common. Much of the acreage of the Ector soils is in the northwestern part of the county, though some areas are in the Anacacho Mountains in the southeastern part.

Limestone rockland is very steep, stony, and bouldery. Dark-colored material is in the pockets and crevices in the rocks. Slopes generally range from 20 to 70 percent, but many of the canyon walls are vertical and are as much as 300 feet high.

The Dev soils are gravelly and stony; they lie on the bottom lands along some of the creeks. Frio soils are also on bottom lands, but they are not gravelly. Kavett soils are similar to Tarrant soils but are deeper and more nearly level.

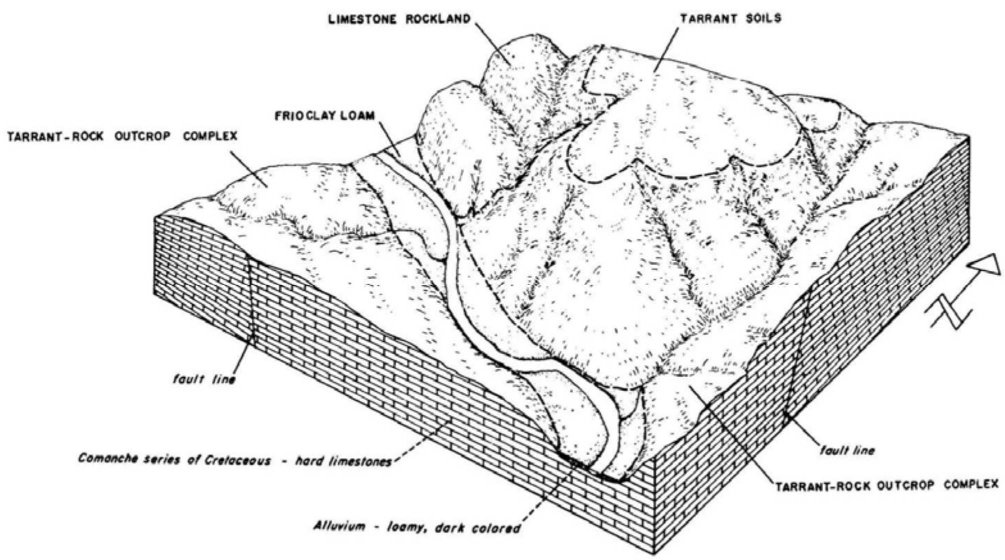

Figure 2.—Soils along the West Nueces River in the northeastern part of the county. Soil association 2.

The soils of this association are used for range, but they are not suited to cultivation. Goats and sheep graze the rough, rocky terrain more easily than cattle, though there are a few cattle on most ranches. A wide variety of grasses, forbs, and shrubs provide palatable food for sheep and goats. Overgrazed areas erode readily. Live oak trees grow in chimps, or motts, in many places on the Tarrant soils, but they do not grow on the Ector soils.

This association is well stocked with deer, and some areas are managed by ranchers for hunting. In the canyons there are numerous scenic spots, many of which can be reached on horseback.

Some rock asphalt is mined in the eastern part of the Anacacho Mountains. Limestone is quarried in some places and is used for roadbuilding materials.

3. Uvalde-Montell association: Deep, nearly level, loamy and clayey soils, moderately permeable and slowly permeable

This association is made up of broad, smooth, nearly level areas of fertile soils in the southern part of the county. Slopes are mainly less than 1 percent. The association has a total area of about 206,500 acres, or about 23 percent of the county.

A Uvalde soil makes up more than 60 percent of the association, and Montell soils make up about 30 percent. Most of the rest of the association is about equally divided among the Frio, Pintas, and Kimbrough soils. Minor areas of Knippa and Reagan soils are also in the association.

The Uvalde soil is a silty clay loam that is dark grayish brown, calcareous, and friable. It is underlain by soft caliche at a depth of about 30 inches. This soil is in slightly higher areas than are the Montell soils, and it is better drained and more permeable.

The Montell soils are deep, grayish, compact, calcareous clays (fig. 3). These soils shrink and crack during dry periods, and they swell or heave during wet periods. Because of this shrinking and swelling, the broad, flat surface appears dimpled.

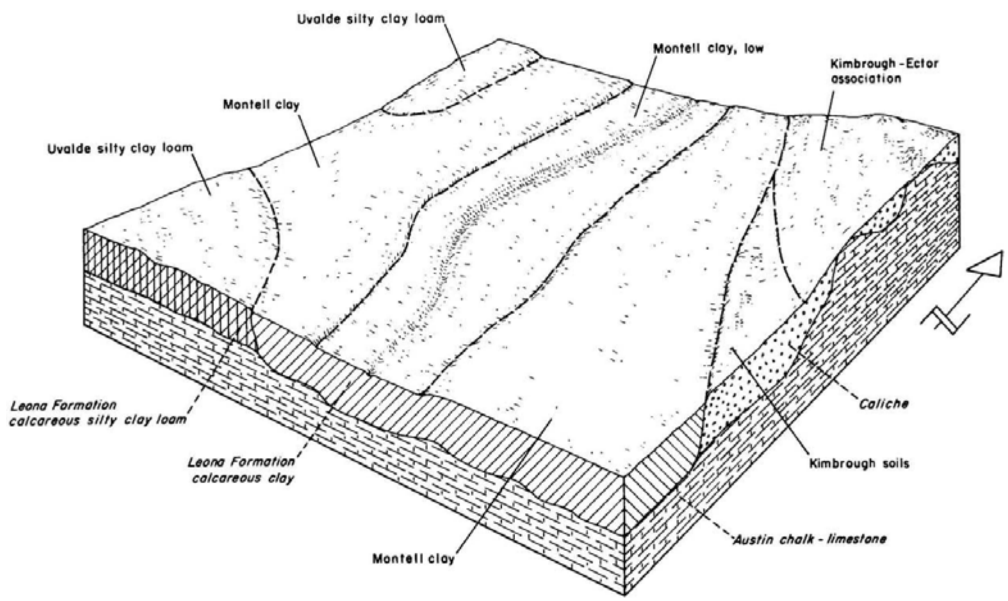

Figure 3.—Soils and underlying substratum in the southern part of the county. Soil association 3.

The Frio and Pintas soils are on bottom lands along creeks and are deep and dark colored. The Kimbrough soils are very shallow and gravelly and overlie hard caliche. They are in slightly higher areas than are the Montell or Uvalde soils.

Most of this association is in range that is easily grazed by cattle. Sheep and goats are also common. Shorter grasses grow on the Montell soils than on the Uvalde soils. Mesquite trees are common on this association.

A few areas of Uvalde soils are irrigated and are well suited to many kinds of fruits and vegetables and to cotton, corn, sorghums, and hay. Also productive are irrigated Montell soils, but these soils are clayey and more difficult to work than the Uvalde soils. In general, erosion is not a problem.

Because of the climate, dryfarming is hazardous on this association; only a small acreage is dryfarmed. Deer, turkeys, and other wildlife are plentiful along the streams where large pecan and live oak trees grow. Farm ponds are common on the Montell soils.

4. Gila-Glendale association: Deep, nearly level, loamy, moderately permeable soils on bottom lands

This association, the smallest in the county, consists of a belt, about one-fourth to 2 miles wide, along the smooth, nearly level flood plain of the Rio Grande (fig. 4). This association has a total area of about 4,500 acres, or less than 1 percent of the county.

Gila loam makes up nearly 50 percent of the association; Glendale clay loam, about 22 percent; and Alluvial land, about 27 percent. Frio clay loam, Pintas silty clay loam, and Uvalde silty clay loam account for the remaining 1 percent.

Alluvial land occurs adjacent to the Rio Grande, only 1 to 10 feet above the channel. Gila loam is adjacent to the Alluvial land. Between the Gila loam and a steep escarpment is Glendale clay loam, which is about 30 to 40 feet above the channel.

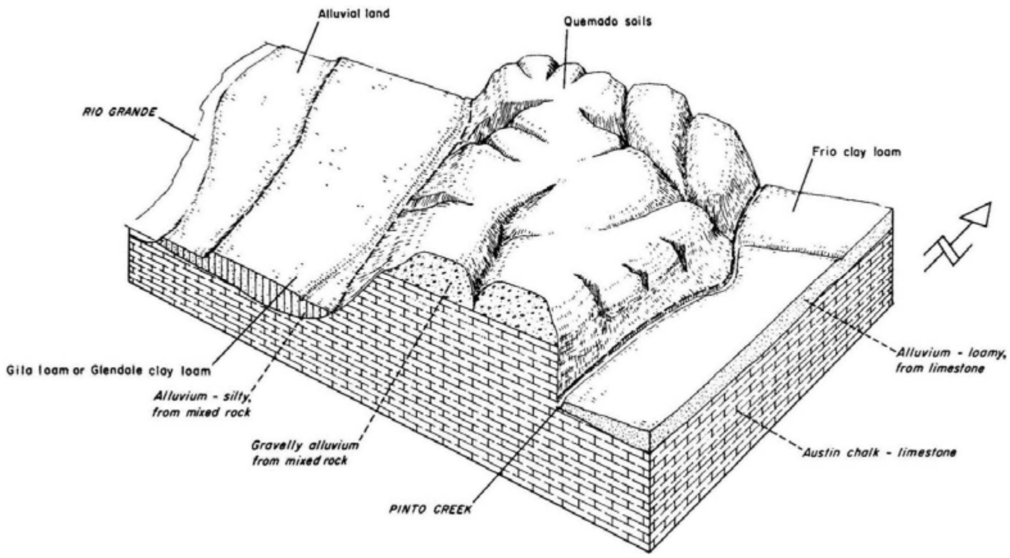

Figure 4.—Soils developed in alluvial materials in the southwestern part of the county. Soil association 4.

Gila loam is light brownish gray and calcareous; it is loam or very fine sandy loam throughout the profile. Glendale clay loam is grayish brown and calcareous; it is clay loam or silty clay loam throughout the profile. Alluvial land is frequently flooded and consists of stratified calcareous loam, sandy loam, silt loam, and loamy fine sand. The Frio, Pintas, and Uvalde soils are deep.

Gila and Glendale soils are cultivated, mostly to irrigated sorghums, but some areas are in dryland blue panicum and plains bristlegrass and are used for grazing. Properly fertilized, irrigated areas of these soils are well suited to many kinds of fruits, vegetables, and field crops. Alluvial land is likely to be flooded and is not suited to cultivated crops, though giantreed grows in a thick stand.

Descriptions of the Soils

The soils of Kinney County are described in alphabetical order in this section. In parenthesis following the name of each soil is the symbol that identifies the soil on the detailed soil map. The descriptions give the characteristics of each soil that distinguishes it from the other soils. The characteristics are those that affect the behavior of the soils under different uses and levels of management.

Use and suitability for range and for cropland are discussed briefly, but these topics are covered more thoroughly in the section "Use and Management of the Soils."

Listed at the end of each description of a soil are the capability unit and the range site in which the soil has been placed. The pages on which the capability unit and the range site are described can be found by referring to the "Guide to Mapping Units" at the back of this report.

Soil scientists, engineers, students, and others who want detailed descriptions of the soil series should turn to the section "Formation, Classification, and Morphology of Soils." Many terms used in the soil descriptions and other sections are defined in the "Soil Survey Manual" (*6*) and in the Glossary. Table 1 gives the approximate acreage and the proportionate extent of the soils.

Alluvial land (Al) occurs along the Rio Grande and is only 1 to 10 feet higher than the river channel. It is 10 to 20 feet lower than Gila loam on the stream terraces. Alluvial land is frequently damaged by floods that deposit and remove material.

This land is gently undulating or has low ridges that parallel the river channel. In many places a high water table subirrigates the soil material. Surface water stands most of the time in sloughs, low areas, and potholes. Scour channels and saline spots are common.

In most areas the soil material consists of well-stratified, thick and thin layers of various texture. The material is dominantly sandy loam or silt loam; less than 10 percent is loamy sand. The soil material is calcareous and mostly very pale brown.

Alluvial land is locally called the Vega, which means flat lowland in Spanish. It is used entirely as range. (Capability unit *Vw*-2; Vega range site)

Dev soils (0 to 2 percent slopes) (Ds) are deep, dark colored, calcareous, and very gravelly. These soils are in the northern part of the county on bottom land along streams that have a steep gradient. They are in bands 50 to 200 yards wide. Damaging floods both deposit and remove material. Low ridges and swales that are stony and gravelly parallel the streams in many places. Slopes vary within short distances.

The surface layer averages about 14 inches in thickness and is dark grayish-brown clay loam. Within distances of less than 100 feet, this layer ranges from 10 to 25 inches in thickness. More than 50 percent of this layer, by volume, is made up of well-graded, subrounded limestone pebbles and cobbles and some stones and boulders. The underlying material—calcareous, pale brown, and loamy is over hard limestone at a depth below 6 feet. Limestone pebbles and cobbles make up about 75 percent of the underlying material.

Included in areas mapped as these soils are some small areas of Frio clay loam and some gravel bars and old stream channels. These included areas are generally long, narrow strips parallel to the stream.

Dev soils have rapid permeability and are well drained. Runoff is slow, and the hazard of flooding is severe. These soils are subject to water erosion. Natural fertility is high. Although available water capacity is low, the water table is within reach of plant roots in places.

These soils are in range and support a moderate cover of grasses and forbs; mesquite, cedar, and persimmon trees; and thorny brush. Live oak and pecan trees grow in places.

Dev soils are not suited to crops, because flooding is likely. Large amounts of pebbles and stones are in the soils. These soils are suited to limited grazing by sheep, goats, and cattle. Generally, water for livestock is available in the streams. (Capability unit VIw-1; Overflow range site)

Ector-Rock outcrop complex (5 to 20 percent slopes) (Et) consists of outcrops of limestone intermingled with very shallow, grayish-brown, calcareous stony clay loams that overlie hard limestone. The complex is mainly in the Anacacho Mountains in the southeastern part of the county. Boulders occur in many places. The outcrops are in bands that are about 5 to 10 feet wide and extend on the contour around the hills and ridges. These bands are about 30 to 150 feet apart. The outcrops make up about 50 percent of some areas of this complex but average about 20 percent. In places about 80 to 90 percent of the surface is covered with pebbles, cobbles, stones, and boulders. Slopes are generally between 5 and 20 percent, but they range from 1 to 35.

The surface layer is about 5 inches of friable clay loam that has moderate granular structure. About 40 percent of the surface layer, by volume, consists of limestone pebbles and cobbles and some stones.

The underlying material is coarse-grained, yellow limestone that contains many fossils. In most places caliche coats the upper rocks and fills fractures in the limestone.

Some narrow bands of Ector soils occur along the foot slopes of mountains. Areas of Limestone rockland are along the canyon walls and on steep mountainsides, where elevations differ as much as 300 feet within short distances. This rockland makes up 10 percent of the mapped acreage. Dev soils, Reagan loam, and Uvalde silty clay loam occur in a few small areas along some of the narrow canyons. Tarrant soils are in small areas on the uppermost parts of mesas in the northeastern part of the Anacacho Mountains.

Ector-Rock outcrop has rapid runoff and is well drained. The Ector soils have moderately rapid permeability in the surface layer and subsoil but moderately slow permeability in the underlying material. Natural fertility is high. Because these soils are shallow, they have low available water capacity. They are highly susceptible to water erosion.

This complex is unsuited as cropland, but it is well suited for grazing by sheep, goats, and cattle. On it are many kinds of grasses, forbs, and brush. Controlling brush by mechanical methods is difficult because stones, boulders, rock outcrops, steep slopes and hard limestone are on or near the surface. (Ector soils in capability unit VIIs-1, and Anacacho Hill range site; rock outcrop not assigned to a capability unit or range site)

Ector soils (1 to 20 percent slopes) (Ec) overlie hard limestone and are very shallow, grayish brown, calcareous, and stony. These soils occur in broad, undulating to hilly areas in the northwestern part of the county. Average slopes are between 8 and 10 percent.

The surface layer, about 8 inches thick, is friable loam or light clay loam that has weak granular structure. About 30 percent of this layer consists of angular pebbles and cobbles of limestone and a few stones. In some places as much as 85 percent of the soil surface is covered with limestone fragments, many of which are stones and boulders. The underlying material is white limestone many feet thick. In most places caliche coats the upper part of the limestone and fills the cracks and crevices in it.

Included in areas mapped as these soils are a few, small areas of Dev soils, of Frio clay loam, of Uvalde silty clay loam, of Reagan loam, and of Limestone rockland. Dev soils and Frio clay loam are along small, intermittent streams in areas less than 5 acres in size. Limestone rockland is along canyon walls that have slopes of 20 to 70 percent. It is in areas as much as 20 acres in size and makes up about 5 percent of the acreage mapped as Ector soils. Inclusions of rock outcrops range from small isolated spots to larger areas that make up as much as 10 percent of a mapped area. The outcrops are generally in bands on the contour around hills and ridges. These bands are 3 to 8 feet wide and about 50 to 200 feet apart.

Ector soils are well drained. Runoff is rapid, and internal drainage is medium and rapid. Permeability is moderate in the surface layer and subsoil but is moderately slow in the underlying material. These soils are medium in natural fertility. Because they are very shallow, they have low available water capacity. They are moderately susceptible to highly susceptible to water erosion.

These soils are not suited to crops, but they are well suited as range that can be grazed by sheep, goats, and cattle. Vegetation consists mainly of mid and short grasses and of guajillo, catclaw, coyotillo, cactus, and other woody plants. (Capability unit VIIs-1; Low Stony Hill range site)

Frio clay loam (0 to 1 percent slopes) (Fr).—This soil is on smooth, nearly level flood plains and is deep, friable, dark colored, and calcareous. It is in bands, 100 to 400 yards wide, that parallel streams. These streams have channels that are large enough to carry away the runoff water from most rains, and flooding is only occasional. Slopes are generally less than 1 percent.

The surface layer, about 20 inches thick, is dark grayish-brown clay loam that has weak or moderate, fine, granular structure. This layer contains many earthworm

casts, fine pores, and pieces of snail shells. The subsoil, about 15 inches thick, resembles the surface layer but is brown instead of dark grayish brown. In places the subsoil contains waterworn limestone gravel. The underlying material is made up of friable, brown to pale-brown silty and loamy sediment that is readily penetrated by plant roots. This sediment was washed from limestone material and is gravelly and stratified in places. In most areas ground water is within 6 to 20 feet of the surface.

Included in areas mapped as this soil were areas of Frio soils that have a silty clay, clay, or silty clay loam surface layer. Also included are some spots of Frio clay loam that have slopes of slightly more than 1 percent. Mainly along the West Nueces River, there are a few small strips of Dev soils. Along Las Moras, Pinto, and Mud Creeks are small included areas of Pintas silty clay loam. All areas of these inclusions make up less than 5 percent of the areas mapped as Frio clay loam.

Frio clay loam is well drained and has medium internal drainage and moderate permeability. Runoff is slow. Natural fertility and available water capacity are high. This soil is slightly susceptible to water erosion and to flooding.

Nearly all of this soil is in range. The stands of grasses are good, and there are native pecan, live oak, and mesquite trees and many kinds of smaller brushy plants. A few small tame pastures that are planted to sorghum almum, blue panicum, sudangrass, or plains bristlegrass are grazed by beef cattle and sheep during spring and summer. In winter the livestock graze a few small fields of small grain, mainly oats. A small acreage is used for irrigated sorghums, alfalfa, bermudagrass, and vegetables.

This soil is well suited to irrigated crops, including vegetables. Some adapted crops are cotton, corn, sorghums, and alfalfa. Bermudagrass is suitable for hay or grazing. Among the suitable vegetables are beans, cabbage, carrots, cucumbers, cauliflower, onions, spinach, lettuce, peppers, tomatoes, melons, peas, and Irish potatoes. Improved varieties of pecans are grown in groves, and other crops are planted between the trees. Grapes grow well in irrigated areas.

Tame grasses die out during severe droughts, and even in years of normal rainfall, little forage is produced during summer. A stand of winter oats for grazing should be expected only about 3 years in every 5. Moisture is seldom sufficient for producing a crop of oats for grain.

In some areas where the water table is within reach of tree roots, pecan trees can be planted on this soil. Because the underlying material is permeable, ponds built on this soil do not hold water. (Capability unit IVc-1, nonirrigated; I-1, irrigated; Loamy Bottom Land range site)

Gila loam (0 to 1 percent slopes) (Gm).—This soil is deep, very friable, light colored, and calcareous. It is on the flood plain of the Rio Grande and is about 20 to 30 feet higher than the river channel. This soil is in a smooth, nearly level, almost continuous area that is 15 miles long and averages 1/4 mile in width. Slopes are generally less than one-half percent.

The surface layer, about 20 inches thick, is light brownish gray and has weak granular structure. It contains earthworm casts, fine pores, pieces of snail shells, a few fine pebbles, and fine, glittering flakes of mica. Below this layer is friable, pale-brown, limy loam or very fine sandy loam that is readily penetrated by plant roots and is thinly stratified with sands and silts.

Included in areas mapped as this soil are a few small spots of Glendale clay loam that are less than 1 acre in size. They are darker and slightly lower than the surrounding landscape.

Gila loam is well drained; it has medium internal drainage and moderate permeability. Runoff is very slow. Natural fertility is high, and available water capacity is moderately good, Unless this soil is irrigated, it is seldom wet below a depth of 2

feet. It is slightly susceptible to wind and water erosion and is seldom, if ever, flooded.

This soil is used mainly for irrigated grain sorghum and forage sorghum. Some of the dryfarmed areas are seeded to tame pastures consisting of blue panicum and plains bristlegrass and are grazed by beef cattle and sheep. Only a small acreage remains in range.

This soil is well suited to irrigated crops, including vegetables. Some adapted crops are cotton, corn, sorghums, and alfalfa, Bermudagrass is suitable for hay or grazing. Among the suitable vegetables are onions, spinach, lettuce, cabbage, peppers, tomatoes, cucumbers, melons, carrots, peas, beans, cauliflower, and Irish potatoes. Improved varieties of pecans are grown in groves, and other crops are planted between the trees. Grapes grow well in irrigated areas.

If tame grasses are seeded for pasture and are not irrigated, they die out during severe droughts and have to be replanted. Because the underlying material is permeable, ponds built on this soil do not hold water. (Capability unit IVc-1, nonirrigated; I-1, irrigated; Clay Loam range site)

Glendale clay loam (0 to 1 percent slopes) (Gc).—This soil is deep, friable, grayish brown, and calcareous. It occupies the bottom land along the Rio Grande and is about 30 to 40 feet higher than the river channel. It occurs in a smooth, nearly level area that is less than 400 yards wide and about 9 miles long. Slopes are generally less than one-half percent.

The surface layer, about 24 inches thick, is grayish brown and has weak or moderate granular structure. It contains many earthworm casts, fine pores, pieces of snail shells, and fine, glittering flakes of mica. The subsoil resembles the surface layer but is brown or pale brown and about 15 inches thick. Below this layer is friable, very pale brown, limy, silty material that is readily penetrated by plant roots and is thinly stratified with loams and clays.

Included in areas mapped as this soil are a few, long, narrow strips of Gila loam that are less than 2 acres in size. These strips parallel the river. Unless they have been leveled, they are slightly higher than the surrounding landscape. Also included with Glendale clay loam are areas of Glendale soil that have a silty clay loam surface layer.

Glendale clay loam is well drained; it has medium internal drainage and moderate permeability. Runoff is slow. Natural fertility is high, and available water capacity is good. Because the climate is semiarid, nonirrigated areas of this soil are seldom wet below a depth of 2 feet. This soil is slightly susceptible to wind and water erosion, but it is seldom, if ever, flooded.

This soil is used mainly for irrigated grain sorghum and forage sorghum. Some of the dryfarmed areas are planted to tame pasture consisting of blue panicum and plains bristlegrass and are grazed by beef cattle and sheep. Only a small acreage is still in range.

This soil is well suited to irrigated crops, including vegetables. Some adapted crops are cotton, corn, sorghums, and alfalfa. Bermudagrass is suitable for hay or grazing. Among the suitable vegetables are onions, spinach, lettuce, cabbage, peppers, tomatoes, cucumbers, melons, carrots, peas, beans, cauliflower, and Irish potatoes. Also suitable are improved varieties of pecans. The pecan trees are grown in groves, and other crops are planted between the trees. Grapes grow well in irrigated areas.

If tame grasses are seeded for pasture and are not irrigated, they die out during severe droughts and have to be replanted. Because the underlying material is permeable, ponds built on this soil do not hold water, (Capability unit IVc-1, nonirrigated; I-1, irrigated; Clay Loam range site)

Ingram stony clay (5 to 20 percent slopes) (In).—This soil is shallow, dark brown, firm, and neutral to moderately alkaline. It formed from basaltic rocks on six hills, or peaks, in the county. Some of these peaks rise as much as 500 feet above the surrounding plain. They are prominent landmarks and are called by such names as Elm, Las Moras, Pinto, and Turkey Mountains, of this soil are roughly circular in shape, and range from 30 to 300 acres in size. Slopes average 10 percent.

The surface layer, about 12 inches thick, is dark brown and has moderate subangular blocky or blocky structure. Many fragments of basalt are on the surface and in the surface layer, These fragments range from pebbles to boulders. About 20 percent of the volume of the fragments consists of boulders more than 10 inches across. The subsoil, about 6 inches thick, resembles the surface layer but is reddish brown to brown in color. In places it is calcareous. About 50 to 90 percent of the subsoil, by volume, consists of basaltic stones, cobbles, and pebbles. The underlying material is partly weathered basalt that is fractured in the upper few feet. In a few places calcium carbonate is in cracks, crevices, and pockets within the upper few inches of the underlying material. This layer grades into hard basalt, which is the remains of volcanic sills.

Included in areas mapped as this soil are strips of very shallow soils and outcrops of rubble on very steep slopes. These inclusions make up about 10 percent of each area mapped on Pinto, Las Moras, and Turkey Mountains.

Ingram stony clay is well drained. Runoff is rapid, and internal drainage and permeability are slow. Natural fertility is high, because this soil is shallow, has only moderate capacity to hold water. It is highly susceptible to water erosion.

This soil is unsuited to crops but is well suited as ran that is grazed by sheep and goats. The grasses include sideoats grama, feathery bluestems, lovegrass tridens, spike bristlegrass, fall witchgrass, and hairy grama. The woody plants include guajillo, whitebrush, and blackbrush. (Capability unit VIs-2; Shallow Ridge range site)

Jimenez-Zapata association (5 to 20 percent slopes) (Jm) consists of very shallow, grayish-brown and light brownish-gray loams that are calcareous and gravelly. These soils occur on undulating to rolling ridges in the southwestern part of the county. Many areas have short, choppy slopes and locally are deeply cut by drainageways into a complex pattern. The areas parallel the Rio Grande and range from 1/2 to 2 miles in width. Slopes vary greatly within distances of a few feet. In about 55 percent of each area, slopes range from 8 to 20 percent, but in about 35 percent, slopes are less than 8 percent. Some areas have slopes as steep as 30 percent.

The Jimenez soils make up about 50 percent of the association, and the Zapata soils make up about 30 percent. The rest of the association is made up of Ector soils, of Quemado soils, of Limestone rockland, and of small areas of other soils.

The Jimenez soils generally occur on ridge crests and the more gentle slopes, but in some places they extend from the crests down side slopes of as much as 15 percent. The surface layer is grayish-brown, friable loam about 8 inches thick. More than 50 percent of the surface layer, by volume, consists of pebbles less than 3 inches in size. The pebbles are waterworn quartz, chert, limestone, sandstone, and basalt. The underlying material is gravelly caliche that contains the same kinds and amounts of pebbles as are in the surface layer. This caliche is indurated in the upper 8 to 20 inches, but it is softer below. It is underlain by chalky limestone at a depth of 3 to 20 feet.

Zapata soils occur mainly on the steeper slopes and on benches along some of the small drainageways or creeks. The surface layer, about 8 inches thick, is light brownish-gray loam. Pebbles less than 3 inches in size make up 20 to 80 percent of this layer, by volume. These pebbles are waterworn quartz, chert, limestone,

sandstone, and basalt. Zapata soils are lighter colored than Jimenez soils but have the same kind of underlying material.

The Ector soils are gravelly loams that have slopes of 2 to 8 percent. They are in some of the drainageways and valleys and make up 8 percent of the association. The Quemado soils occur in long, narrow areas on flat crests of ridges. Limestone rockland is very steep. It is in a long, narrow band along the break between the flood plain of the Rio Grande and the gravelly uplands. It is also in some places along Pinto Creek and in some of the more deeply cut drainageways. Dev soils, Frio clay loam, Reagan loam, and Uvalde silty clay loam are in small areas along some of the creeks.

The soils in this association are well drained. Runoff is rapid, and internal drainage is medium to rapid. Permeability is moderate in the surface layer and subsoil but is moderately slow in the underlying material. These soils are about medium in natural fertility. Because they are very shallow, they have low available water capacity. They are highly susceptible to water erosion.

The soils in this association are not suited to crops, though native vegetation can be grown that furnishes limited grazing for sheep, goats, and cattle. The vegetation consists of sparse stands of grasses and of guajillo, cenizo, blackbrush, paloverde, spiny hackberry, and other brush.

Some areas on the ends of ridges facing the Rio Grande are mined for road materials. In these areas waterworn pebbles and gravel make up 80 to 90 percent of the soil mass. (Capability unit VIIs-2; Gravelly Ridge range site)

Kavett-Tarrant stony clays (0 to 3 percent slopes) (Kc) is a complex of shallow and very shallow, dark-colored stony soils that overlie hard limestone. These soils were mapped as a complex because they could not be shown separately on a map of the scale used. They occur in nearly level to gently sloping valleys in the northern part of the county.

Kavett soils make up about 55 percent of this complex, and Tarrant soils make up about 35 percent. The rest consists of small areas of Dev soils, of a deep soil similar to the Knippa soils, and of rock outcrops.

The Kavett soils are deeper and less stony than the very shallow Tarrant soils. Most areas of the Kavett soils are nearly level, but the Tarrant soils are gently sloping. Most areas of Tarrant soils are less than 10 acres in size, but some areas are as large as 20 acres.

The surface layer of Kavett stony clay is very dark grayish-brown, firm, neutral to moderately alkaline clay about 9 inches thick. It has moderate, medium, subangular blocky structure. About 10 to 20 percent of this layer, by volume, consists of limestone cobbles, pebbles, and stones. In places as much as 50 percent of the surface is covered with limestone fragments. The subsoil, about 6 inches thick, is dark grayish brown and calcareous, but it is otherwise similar to the surface layer. The underlying material is mostly white, fractured limestone but has some cemented caliche in the upper part.

The surface layer and underlying material of Tarrant stony clay are similar to those described for the mapping unit Tarrant soils.

In areas mapped as this complex are small, level areas of a deep soil that occurs in the lowest part of the landscape. Except for its grayer color, this deep soil is similar to Knippa silty clay. Areas of this deep soil are made conspicuous in the landscape by the absence of live oak and the presence of mesquite trees. These soils are deeper, more clayey, and less permeable than Kavett soils and have a more blocky structure. Small areas of Dev soils are along small creeks. Isolated outcrops of rocks occur in places.

Kavett-Tarrant stony clays are well drained. Runoff is slow, and internal drainage is medium. Permeability is moderate in the surface layer and subsoil but is

moderately slow in the underlying material. Natural fertility is high. Because they are shallow, these soils have low available water capacity. They are only slightly susceptible to water erosion.

These soils are well suited as range but are unsuited to crops. They support a good stand of mid grass if they are properly grazed and are in good condition. The woody plants include live oak trees, juniper, catclaw, and persimmon. (Kavett soils, capability unit VIs-4, Shallow range site, Edwards Plateau; Tarrant soil, capability unit VIs-3, Low Stony Hill range site)

Kimbrough-Ector association (1 to 8 percent slopes) (Ke) consists of very shallow, grayish-brown loams that are calcareous and gravelly. Most areas of this association are on broad, undulating ridges in a wide belt across the central part of the county. These areas are generally several thousand acres in size. These soils were mapped in an association because they are somewhat similar and produce similar kinds and amounts of range vegetation.

The Kimbrough soils make up about 55 percent of the association, and the Ector soils make up about 40 percent.

The rest of the association is made up of Dev soils, Frio clay loam, Uvalde silty clay loam, and of limestone outcrops.

The Kimbrough soils generally occur in wide, nearly level valleys and other areas below the Ector soils, but they also are in the more gently sloping areas in the undulating landscape. Their surface layer and the underlying material resemble those of the mapping unit Kimbrough soils, though limestone is within 18 inches of the surface in many places.

The Ector soils generally occur on ridge crests and in the more sloping areas. The surface layer, about 5 inches thick, is friable loam and has weak granular structure. About 30 to 50 percent of the surface layer, by volume, consists of limestone and caliche pebbles or fragments less than 3 inches across. Below this layer is discontinuous, hardened caliche over limestone. The caliche is in pockets and crevices of the limestone and in places, especially on flat ridge crests, is continuous over the limestone.

Included in areas mapped as this association are small, narrow areas of Dev soils, Frio clay loam, and Uvalde silty clay loam. These areas are along drainageways or intermittent streams and make up less than 5 percent of the association. Also included are a few small isolated outcrops of limestone.

The soils in this association are well drained. Runoff is slow to rapid, and internal drainage is medium to rapid. Permeability is moderate in the surface layer and subsoil but is moderately slow in the underlying material. These soils are about medium in natural fertility. Because they are very shallow, they have low available water capacity. They are moderately susceptible to highly susceptible to water erosion.

The soils in this association are not suited to crops but are well suited as range that furnishes grazing for sheep, goats, and cattle. The vegetation consists mainly of mid and short grasses and the woody plant, guajillo. Other woody plants include catclaw, cenizo, leatherstem, and cactus.

Although the Kimbrough and Ector soils are hard to distinguish, engineers can dig through the indurated caliche of the Kimbrough soils. In many places drilling and blasting are needed for preparing roadbeds in the Ector soils. (Capability unit VIIs-2; Shallow Ridge range site)

Kimbrough soils (0 to 2 percent slopes) (Kh) are grayish brown, calcareous, gravelly, and very shallow over caliche. These gravelly soils occur in broad, nearly level to gently sloping areas, mainly in the southern part of the county. Many of these areas, hundreds of acres in size, are nearly fiat divides between creeks. Slopes are generally less than 1 percent.

The surface layer, about 5 inches thick, is friable loam or light clay loam. It has weak granular structure. About 40 to 50 percent of this layer, by volume, consists of caliche and limestone fragments less than 3 inches in size. The underlying material is a bed of white caliche several feet thick. The upper 2 to 10 inches of this bed is very hard and is broken into plates to 3 inches thick and as much as 12 inches across. Between these plates is a small amount of soil material. Below this hard, broken layer, the caliche becomes massive, somewhat softer, and nodular as depth increases.

Included in areas mapped as these soils are small areas of Uvalde silty clay loam and Reagan loam in slight depressions. In places these areas are as much as 10 acres in size, but they generally are less than 100 feet across. They make up about 10 percent of the acreage in mapped areas.

Kimbrough soils are well drained. Runoff is slow to rapid, and internal drainage is rapid. Permeability is moderate in the surface layer and subsoil but is moderately slow in the underlying material. Natural fertility is medium. Because these soils are very shallow, they have low available water capacity. They are slightly susceptible or moderately susceptible to water erosion.

These soils are suited as range that furnishes grazing for sheep, goats, and cattle. They are not suited to crops. On these soils are bristlegrasses, red grama, pink pappusgrass, plains lovegrass, sideoats grama, and other mid and short grasses. The woody plants are mainly guajillo, but there is some blackbrush, whitebrush, leatherstem, cenizo, guayacan, and pricklypear cactus. (Capability unit VIIs-2; Shallow Ridge range site)

Knippa silty clay (0 to 1 percent slopes) (Kn).—This soil is deep, dark colored, firm, and calcareous. It occurs mainly in the central part of the county in smooth, nearly level valleys that average 1/2 mile in width and 3 or 4 miles in length. Areas of this soil extend from the foot slopes of the Edwards Plateau to the flood plain of the Rio Grande. Slopes are generally less than 1 percent.

The surface layer is about 20 inches of dark grayish-brown to brown silty clay or clay. It generally consists of two parts. The upper part of this layer has granular to subangular blocky structure, but in the lower part structure is moderate blocky. The reddish-brown to brown subsoil is also about 20 inches thick. It has weak or moderate blocky structure. The subsoil contains more lime but less organic matter than the surface layer. The underlying material is calcareous clayey outwash that is very pale brown to yellowish brown. The upper 6 to 18 inches of this layer contains more lime than the lower part.

Included in areas mapped as this soil are small areas of very shallow Kimbrough soils and of Uvalde silty clay loam. Caliche fragments are on the surface of the Kimbrough soils. Also included, mostly in the upper parts of valleys, are small areas of a soil that has thinner layers and a gravelly substratum. The total acreage of the included areas amounts to less than 3 percent of the acreage mapped as Knippa silty clay.

This soil is well drained. Runoff is slow. Internal drainage is medium, and permeability is moderate to slow. Available water capacity and natural fertility are high. This soil is slightly susceptible to water erosion.

Knippa silty clay is in range, for which it is well suited, but it is also suitable for irrigation. In this dry climate, this soil is not suitable for dryfarming. Prominent native plants are vine-mesquite, curly mesquite, sideoats grama, fall witchgrass, tobosa, pink pappusgrass, and other grasses. The woody plants are mainly mesquite, whitebrush, condalia, and spiny hackberry. Highly productive grasses can be maintained if good practices of range management are followed.

Cotton, corn, sorghums, alfalfa, and bermudagrass are among the suitable irrigated crops. Among the adapted vegetables are beans, cabbage, cucumbers,

onions, spinach, lettuce, peppers, tomatoes, melons, and peas. (Capability unit Vs-1, nonirrigated; IIs-4, irrigated; Clay Loam range site)

Limestone rockland (20 to 70 percent slopes) (Lr) occurs mainly in the northern part of the county. It consists of very steep stony rockland that has dark grayish-brown to black clay in pockets and crevices of the rocks. More than 20 percent of the surface is covered by ledges of limestone and other exposures of rocks. Angular cobbles, stories, and boulders cover 80 to 90 percent of the surface between these ledges and outcrops. In some areas pockets of soil extend to a depth of 2 feet or more, and in places soil material is in horizontal fractures. Slopes average about 35 percent.

Included in areas mapped as Limestone rockland are areas of Tarrant-Rock outcrop complex, generally less than 40 acres in size. These inclusions make up less than 15 percent of the acreage in mapped areas.

The vegetation consists of sparse stands of tall and mid grasses and of woody plants, including cedar, live oak, shin oak, pinyon pine, sumac, mesealbean, coyotillo, and cactus.

Limestone rockland is so rough and rocky that it can be grazed more readily by sheep and goats than by cattle. Many areas can be easily overgrazed, and other areas may not be grazed at all. Overgrazed areas erode readily. (Capability unit VIIs-3; Steep Rocky range site)

Montell clay (0 to 1 percent slopes) (Mc) is deep, grayish, and calcareous. It occurs in broad, smooth, nearly level areas, mainly in the southern part of the county. Most slopes are less than one-half percent.

The surface layer, about. 30 inches thick, is gray clay that is very firm when moist and very hard when dry. The upper one-third of this layer had weak blocky structure, and the lower two-thirds has moderate, medium, blocky structure. When dry, the uppermost 1 inch of soil forms a mulch of very hard, very fine, angular aggregates.

The subsoil, about 15 inches thick, is grayish-brown clay that has weak to moderate, medium, blocky structure. It is very firm when moist and very hard when dry. In some places it is moderately saline. The underlying material is pale-brown, calcareous clay outwash that contains gypsum crystals and perhaps other salts. It is moderately saline to strongly saline. In some places it is gravelly below a depth of 5 feet.

When this soil dries, it shrinks and cracks, and when it is wet, it swells and heaves (fig. 5). Because of this shrinking and swelling, the surface of this soil has high and low spots that give it a dimpled appearance. Both the high and the low spots occur within a distance of 10 to 30 feet. The high areas are 2 to 6 inches above the low areas. Within short distances, the thickness of the surface layer ranges from as little as 15 inches in the high areas to as much as 35 inches in the low areas. The thickness of the subsoil ranges from 10 to 20 inches.

Included in areas mapped as this soil are small mounds of lighter colored Uvalde silty clay loam and small areas of Kimbrough soils. Grasses are taller on the Uvalde soil than on Montell clay, and many caliche fragments are on the surface of the Kimbrough soil. Also included in mapping are a few small areas of Montell clay, low, in slight depressions where water runs during rainy periods.

Montell clay is moderately well drained but has very slow runoff. Internal drainage and permeability are slow to very slow. Natural fertility and available water capacity are high. Erosion is not a problem.

This soil is well suited to irrigated crops, though it takes in water slowly. Rainfall is so low that dryfarming is not a good practice. Most areas are in native grasses and are grazed. The dominant grasses include pink pappusgrass, vine-mesquite, white tridens, tobosa, bristlegrasses, curly mesquite, and red grama. Mesquite is the main woody plant, but whitebrush and condalia grow in places. A vigorous stand of highly

productive grasses can be maintained if good practices of range management are followed.

Some of the irrigated crops are cotton, grain and forage sorghums, alfalfa, and bermudagrass. Among the suitable vegetables are cabbage, peppers, tomatoes, and peas. Carrots and potatoes do not grow so well on this clayey soil as they do on more friable soil, and their value on the market is lowered by the misshapen roots or tubers that form. (Capability unit Vs-1, nonirrigated; IIs-1, irrigated; Clay Flat range site)

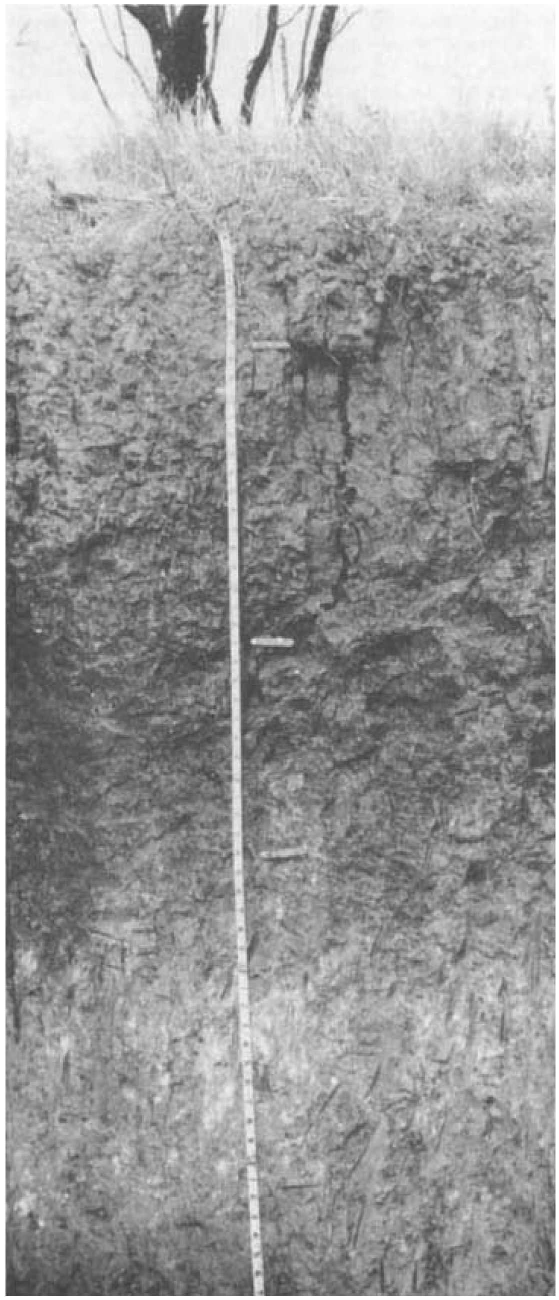

Figure 5.—This Montell clay cracked deeply when it dried and shrank.

Montell clay, low (0 to 1 percent slopes) (Mo).—This soil is deep, dense, firm, dark gray, and calcareous. It is slightly saline to strongly saline. Most areas occur along flat, shallow drainageways and are several miles long and less than one-fourth mile wide. These drainageways do not have well-defined stream channels. In the southern part of the county, the drainageways are 1 to 6 feet below the surrounding plain.

The surface layer, about 20 inches thick, is dark-gray clay that is firm when moist and extremely hard when dry. It has weak to moderate, medium and fine, blocky structure that, when the soil is wet, appears to be massive. The upper one-third of the surface layer is less dense and less saline than the lower part. When dry, the uppermost 1 inch of soil forms a mulch of very hard, very fine, angular aggregates. The surface layer is generally slightly saline, but it is strongly saline in about 10 percent of the acreage. The subsoil, about 10 inches thick, is gray, strongly saline clay that has weak blocky structure. It is firm when moist and very hard when dry. This layer contains threads and pockets of carbonates, gypsum, and other salts. The underlying material is light-gray to white, calcareous and gypsiferous clay outwash that is strongly saline and is saturated with water most of the time. In some places it is gravelly.

This soil shrinks and cracks when it dries, and it swells and heaves when it is wet. Because of this shrinking and swelling, the surface of this soil has high and low spots that give it a dimpled appearance. Both high and low spots are within a distance of 10 to 30 feet. The high areas are 2 to 10 inches above the low areas. Within short distances, the thickness of the surface layer ranges from as little as 10 inches in the high areas to as much as 30 inches in the low areas. The thickness of the subsoil ranges from 6 to 15 inches.

Included in areas mapped as this soil are small areas of Montell clay and some small enclosed depressions, or natural lakes, that hold water for a few days after heavy rains.

Montell clay, low, is imperfectly drained or moderately well drained. Internal drainage and permeability are very slow. Runoff is very slow, and erosion is not a problem. Natural fertility is moderate to high, and available water capacity is high. Because this soil is saline, only salt-tolerant plants can use water from below a depth of 2 feet.

Montell clay, low, is too dry for dryfarming, and it is not suitable for irrigation in the strongly saline areas. It is used for range and supports a good cover of curly mesquite, tobosa, giant sacaton, and plains bristlegrass. Alkali sacaton is the main grass in some of the more saline areas. Mesquite brush is the main invader in overgrazed areas.

Because establishing new grass seedlings on this heavy saline clay is difficult in this dry climate, it is best to remove the brush without damaging the grass. Vigorous stands of highly productive grasses can be maintained if good practices of range management are followed.

Cotton, sorghums, coastal bermudagrass, and alfalfa are among the adapted irrigated crops. (Capability unit Vs-1, nonirrigated; IIIs-1, irrigated; Clay Flat range site)

Pintas silty clay loam (0 to 1 percent slopes) (Pc).—This soil is moderately deep, friable, dark colored, and calcareous. It is in bands 100 to 400 yards wide on smooth, nearly level to gently sloping flood plains along streams. The streams, including Las Moras, Pinto, and Mud Creeks, have a constant flow. Because these streams are not wide or deep enough for carrying large amounts of runoff, this soil is flooded after heavy rains (fig. 6). A water table occurs within 3 to 10 feet of the surface. Slopes are generally less than 1 percent.

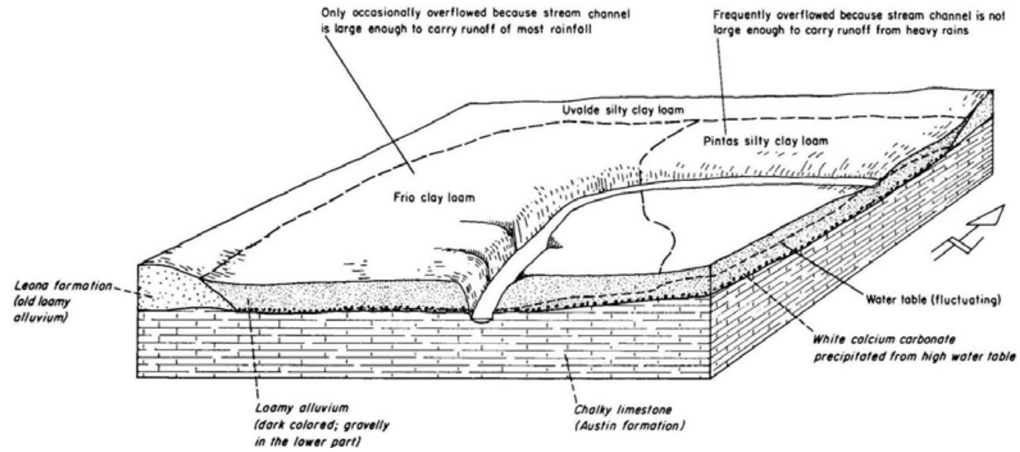

Figure 6.—Soils along a perennial, spring-fed stream. Pintas silty clay loam is near shallow stream channels, and Frio clay loam is near the deeper channels.

The surface layer is about 16 inches thick and, in most places, is very dark gray to black silty clay loam that has weak to moderate, fine, granular structure. At the surface in some areas is a thin, platy layer of recently deposited alluvium. The subsoil about 14 inches thick, resembles the surface layer but is gray, grayish brown, or light brownish gray. The underlying material is a thick, white layer of calcium carbonate that apparently was deposited by ground water from the underlying water-bearing gravel.

Included in areas mapped as this soil are areas of Pintas soils that have a clay, silty clay, or clay surface layer. Also included are a few small areas of Dev soils and of Frio clay loam and a few saline spots that have giant sacation on them. These inclusions make up only a small percentage of the acreage in mapped areas.

The Pintas soil is moderately well drained, Internal drainage is medium, and permeability is moderate. A fluctuating water table subirrigates this soil. Natural fertility and available water capacity are high, but flooding restricts use.

This soil is in range on which there are tall live oak and pecan trees and tall and mid grasses. (Capability unit Vw-1; Loamy Bottom Land range site)

Quemado soils (1 to 5 percent slopes) (Qu).—These shallow or very shallow soils are very gravelly and are underlain by caliche. They have a dark-brown surface layer and are neutral to moderately alkaline. They formed in gravelly alluvium in a few broad, nearly level to gently undulating areas on high terraces near the Rio Grande. Areas of these soils are 100 to 200 feet higher than the river channel. Dominant slopes are between 1 to 5 percent, but the range is from 0 to 8. The steeper areas are along small drainageways.

In many places the surface layer is fine sandy loam. It is about 5 inches thick and has weak granular structure. Pebbles make up more than 50 percent of this layer, by volume. The pebbles are waterworn quartz, chert, sandstone, limestone, and igneous material. The subsoil, about 8 inches thick, is reddish-brown fine sandy loam, but it is more clayey than the surface layer. It also contains waterworn pebbles and is neutral and mildly alkaline. The underlying material is a bed of very gravelly caliche that is several feet thick and is very hard in the upper 4 to 18 inches. The caliche becomes softer as depth increases.

Included in areas mapped as these soils are small areas of Kimbrough soils, Uvalde silty clay loam, and Ector soils that total less than 8 percent of the mapped acreage. Kimbrough soils are generally along the eastern side of the Quemado soils.

Uvalde silty clay loam occurs in very narrow strips along a few drainageways. The Ector soils occur where limestone crops out in a few small areas.

Quemado soils are well drained. Runoff is slow to rapid, and internal drainage is rapid. Permeability is moderately rapid above the caliche. These soils are low to medium in natural fertility, and because they are shallow, available water capacity is low. They are slightly susceptible to moderately susceptible to water erosion.

These soils are unsuited to crops but are suited as range that furnishes grazing for sheep, goats, and cattle. The vegetation consists of a sparse cover of red grama, hairy tridens, three-awns, and Halls panicum, and of woody shrubs including cenizo, guajillo, tasajillo, prickly-pear cactus, leatherstem, and catclaw acacia. (Capability unit VIIs-2; Gravelly Ridge range site)

Reagan loam (0 to 5 percent slopes) (Ra).—This soil occurs on uplands and is moderately deep, light colored, friable, and calcareous. It is on gently sloping foot slopes and on slope breaks along creeks. Slopes are mainly 1 to 3 percent. Most of this soil occurs on the northern side of the Anacacho Mountains and in the southwestern part of Kinney County.

The surface layer, about 10 inches thick, is light brownish-gray loam. It has weak granular and subangular blocky structure. When this layer is dry, it has a soft crust, one-fourth inch thick, at the surface. The subsoil, about 15 inches thick, is pale-brown clay loam. It is strongly calcareous and has weak subangular blocky and granular structure. The upper few inches of the underlying material is a soft layer of very pale brown calcium carbonate. In most places this thin layer is underlain by layers of soft and hard, powdery chalk and in some places by thick beds of soft chalk or caliche. The underlying material is mostly white to pale yellow.

Included in areas mapped as this soil are small areas of Uvalde silty clay loam and Kimbrough soils that make up less than 8 percent of the acreage mapped. The Uvalde series occurs in low, weakly defined drainageways, and the Kimbrough series occurs along the ridge crests. These inclusions are mainly less than 10 acres in size. Also included are areas of Reagan soil that have a clay loam surface layer.

This soil is well drained. Runoff is slow or medium, and internal drainage is medium. Permeability is moderate. Natural fertility and available water capacity are medium. This soil is moderately susceptible to water erosion.

This soil is used for range, which is a good use. Prominent in the vegetation are short and mid grasses, including sideoats grama, Arizona cottontop, plains lovegrass, pink pappusgrass, bristlegrasses, slim tridens, and red grama. The woody plants include mesquite, guajillo, leatherstem, blackbrush, guayacan, and catclaw. A vigorous stand of highly productive grasses can be maintained if good practices of range management are followed.

This soil can also be irrigated. Cotton, sorghums, alfalfa, and bermudagrass are among the suitable crops.

Vegetables are also grown in places. This soil is not suited to dryfarmed crops. (Capability unit VIs-1, nonirrigated; IIIe-1, irrigated; Shallow range site, Rio Grande Plain)

Tarrant-Rock outcrop complex (8 to 20 percent slopes) (Tr) consists of rock outcrops and very shallow, dark-colored, friable stony clay underlain by hard limestone. This complex occurs in the northern part of the county on broad, rolling hills and ridges. Many areas are hundreds of acres in size. In about 70 percent of the acreage, slopes range from 8 to 20 percent, but in about 15 percent, they are less than 8 percent and are in areas less than 50 acres in size. The rest of the complex is made up of other soils or land types. Limestone bedrock crops out in about 15 percent of the mapping unit. These outcrops are on the contour of hills and ridges and are in bands mostly 3 to 8 feet wide. The bands are about 40 to 150 feet apart.

On steeper slopes rock outcrops make up 35 percent of the acreage in mapped areas.

The surface layer ranges from 2 to 12 inches in thickness, but the average is about 6 inches. It is black, dark gray, or very dark grayish brown and has moderate, very fine, granular structure. This layer is mildly alkaline or moderately alkaline. From 40 to 75 percent of the surface is covered by angular limestone pebbles, cobbles, stones, and boulders. Of this area covered by limestone fragments, about 15 percent is covered by fragments larger than 10 inches across. White limestone bedrock many feet thick underlies the surface layer. It is fractured or broken into slabs and has roots and soil material in the cracks in the upper few inches.

In this complex are areas of Limestone rockland that occur in long, narrow strips along the steep canyon walls where slopes range from 20 to 70 percent. These areas are long and very narrow and in places make up 10 percent of the acreage mapped. Also in this complex are very small areas of Dev, Kavett, Uvalde, Frio, and Knippa soils.

The soils in this complex are well drained. Runoff is rapid, and internal drainage is medium to rapid. Permeability is moderate in the surface layer and subsoil but is moderately slow in the underlying material. Natural fertility is high. Because these soils are very shallow, they have low available water capacity. They are moderately susceptible or highly susceptible to water erosion.

These soils are unsuited to crops, but are well suited as range that furnishes grazing for sheep, goats, and cattle. The grasses are sideoats grama, bristlegrasses, fall witchgrass, feathery bluestems, and lovegrass tridens. The woody plants include live oak growing in motts, cedar, pinyon pine, persimmon, mescalbean, and mesquite. The grass and browse are very nutritious.

Mechanical methods of brush control are difficult to apply because of the steep slopes and the stones, boulders, rock outcrops, and hard limestone near the surface.

The Tarrant soils are in capability unit VIs-3 and the Low Stony Hill range site; rock outcrop has not been assigned a capability unit.

Tarrant soils (1 to 8 percent slopes) (Ts) are very shallow, dark-colored, friable soils over hard limestone. In most places these soils are stony clays. Tarrant soils occur on broad, gently undulating to undulating ridges in the northern part of the county. These soils are of minor extent and occur in only a few large areas. In more than 90 percent of the total acreage, slopes range from 1 to 8 percent. Slopes range from 8 to 20 percent in about 5 percent of the acreage, but most areas of these steep soils are less than 20 acres in size. Included in areas mapped as these soils, and making up 5 percent of the total area mapped, are other soils or land types. Outcrops of limestone cover less than 3 percent of the surface.

The surface layer is generally about 8 inches thick but ranges from 2 to 12 inches in thickness. It is dark grayish brown or black and has moderate, very fine, granular structure. This soil is mildly alkaline to moderately alkaline. Limestone fragments, as much as 12 inches across, make up 20 to 50 percent of the soil mass. From 40 to 70 percent of the surface is covered with angular limestone pebbles, cobbles, stones, and boulders. Of the area covered by these fragments, about 10 percent is covered by fragments larger than 10 inches across. The underlying material is white limestone bedrock many feet thick. It is fractured or broken into slabs and, in the upper few inches, there are roots and soil material in the cracks. In some places caliche coats the limestone or is in crevices between the slabs.

Frio, Kavett, Knippa, and Dev soils occur along small intermittent streams, mostly in areas less than 5 acres in size. The rock outcrops range from small isolated outcrops to outcrops covering as much as 10 percent of the surface. Generally, they cover about 3 percent of the surface. The outcrops extend around the hills and ridges in bands 3 to 8 feet wide and 50 to 200 feet apart.

Tarrant soils are well drained. Runoff is slow to rapid, and internal drainage is medium to rapid. Permeability is moderate in the surface soil and subsoil but is moderately slow in the underlying material. Natural fertility is high. Because these soils are very shallow, the available water capacity is low. They are moderately susceptible and highly susceptible to water erosion.

These soils are well suited as range that furnishes grazing for sheep, goats, and cattle but they are unsuited to crops. The same kinds of vegetation grow on these soils as grow on Tarrant-Rock outcrop complex, but production is slightly more favorable. Although the difference is slight, Tarrant soils have slower runoff, hold a little more water, and are less susceptible to erosion than Tarrant-Rock outcrop complex.

Mechanical methods of brush control are difficult to apply because the slopes are steep and stones, boulders, rock outcrops, and hard limestone are near the surface. In the smoother, less rocky areas, small cedars, live oaks, and other trees can be controlled by chaining and bulldozing. (Capability unit VIs-3; Low Stony Hill range site)

Uvalde silty clay loam (0 to 1 percent slopes) (Uv).—This soil is deep, friable, dark colored, and calcareous. It occupies broad, smooth, nearly level to gently sloping areas in the uplands, mainly in the southern two-thirds of the county. Slopes are generally less than 1 percent, but in about 15 percent of the acreage, they are as much as 3 percent.

The surface layer is dark grayish-brown silty clay loam about 17 inches thick. The upper part of this layer has weak and moderate, fine and medium, granular structure, but in the lower part structure is slightly more distinct. In some places structure is subangular blocky in the lower part of the surface layer. This layer is darker and thicker in the more nearly level areas than it is in the more sloping areas. Grayish-brown to pale-brown silty clay loam underlies the surface layer and extends to a depth of 27 inches. This layer has weak subangular blocky to granular structure. It has a higher content of lime than the surface layer but a lower content of organic matter. The underlying material is calcareous, light-brown, silty or loamy outwash that is limy. The upper 6 to 18 inches of this material is rich in lime and is pale brown in color.

Included in areas mapped as this soil are small areas of Montell clay, Knippa silty clay, Kimbrough soils, and Reagan loam. Montell clay and Knippa silty clay are darker colored and lower in the landscape than Uvalde silty clay loam. The areas of Kimbrough soils are less than 10 acres in size and make up as much as 5 percent of any area mapped. Reagan loam is also in very small areas. These spots of Kimbrough soils and of Reagan loam are sloping and slightly higher than the surrounding landscape. Also included are areas of Uvalde soils that have slopes of more than 3 percent. The total area of all the inclusions amounts to less than 10 percent of the acreage mapped as Uvalde silty clay loam.

This Uvalde soil is well drained. Runoff is slow, and internal drainage is medium. Permeability is moderate. Natural fertility and available water capacity are high. This soil is slightly susceptible to water erosion.

Nearly all of this soil is in range, which supports a good stand of grasses and brush. Some of the acreage is used for irrigated sorghums, alfalfa, bermudagrass, and vegetables. A few small dryfarmed areas are planted to small grain, mainly oats, and are grazed during winter. Some small tame pastures are in blue panicum, sudangrass, plains bristlegrass, or sorghum almum. The pastures are grazed by beef cattle and sheep during spring and summer.

This is an excellent soil for irrigated crops, including vegetables. Among the adapted crops are cotton, corn, sorghums, alfalfa, and bermudagrass. Suitable vegetables are beans, cabbage, carrots, cucumbers, cauliflower, onions, spinach,

lettuce, peppers, tomatoes, melons, peas, and Irish potatoes. Grapevines grow well when the vineyards are irrigated. Improved varieties of pecans can be grown in groves, in which other irrigated crops are planted between the trees.

If tame grasses are seeded for pasture and are not irrigated, they die out during severe droughts and have to be replanted. Even in years when there is no severe drought, the summers are so dry that little forage is produced. A stand of winter oats for grazing is expected in only about 3 years in every 5. Moisture is seldom sufficient for producing a crop of oats for grain.

Stands of native grasses can be improved where mesquite trees and other thorny brush are controlled by mechanical methods or by chemical spraying. (Capability unit IVc-2, nonirrigated; 1-2, irrigated; Clay Loam range site)

Use and Management of the Soils

The soils of Kinney County are used mostly for range and, to a smaller extent, for dryland and irrigated crops. This section explains how the soils may be managed for these main purposes, and gives the predicted yields of the principal irrigated crops. In addition, it explains how the soils can be managed for wildlife and for building highways, farm ponds, and other engineering structures. In describing management of range, cropland, and wildlife habitat, the procedure is to group soils that have similar uses and that require similar management, and then to describe management suitable for the group.

Use of the Soils as Range

By Durword. Ball, range conservationist, Soil Conservation Service.

Rangeland consists of soils on which the climax, or potential, plant community is made up mainly of native grasses, forbs, and shrubs that are of sufficient quality and quantity to justify grazing. In Kinney County the native grassland amounts to about 884,000 acres, or about 99 percent of the total acreage. The raising of cattle, goats, and sheep is the main enterprise. All three kinds of livestock are raised on most ranches. Sheep and goats are dominant in the northern part of the county, but sheep and cattle are dominant in the southern part.

The northern one-third of the county consists of hilly limestone areas in which the soils are very shallow and stony. In this area live oaks are the predominant woody plants. Grazing by goats and sheep probably is the best use. In the level to gently rolling southern two-thirds of the county, most areas are not stony and grazing by cattle and sheep is a good use. In this area the main brushy plants are mesquite and guajillo. The forage produced on the very shallow, alkaline soils in the southern part of the county is generally deficient in phosphate because there has been a chemical tieup of phosphorus in the soils.

The rangeland in Kinney County has a long history of grazing, for the county was one of the first settled in the State. The Rio Grande made this area accessible to grazing animals brought in from Mexico. After Fort Clark was established in the middle of the 19th century, most of the grazing was heavy and continuous. Because of this harmful grazing, the better native range plants decreased and brush and inferior plants increased.

The average annual rainfall at Brackettville is 21.1 inches, but in 2 out of every 3 years rainfall is below this average. Droughts that last 2 to 3 years occur about once in every 10 years. Droughts that last more than 3 years occur about once in every 20 to 30 years.

Range sites and condition classes

Rangeland is placed in groupings called range sites according to the kinds and amounts of native vegetation that the soils are capable of producing. Each range site

produces a characteristic plant community that is not found on any other site. Determining the kinds and amounts of plants that can be grown on a specified range site is necessary in planning the management of that site. For example, it is necessary to know that the Loamy Bottom Land range site receives water from floods or runoff and that it is suitable for producing high yields of tall grasses. On the other hand, the Shallow Ridge range site can produce only a small amount of forage. In this county, as elsewhere, range sites differ in their needs for management and in the kinds and numbers of livestock they can support.

Heavy grazing for extended periods reduces the vigor of plants and may result in their elimination. Because livestock graze selectively, the grazing pressure is heaviest on the most palatable plants, and they are eventually destroyed if overuse of a range is continued.

Before the range in this county was grazed by domestic livestock, the vegetation that grew on each soil was the potential, or climax, vegetation. The plants making up the climax vegetation are called *increasers* or *decreasers,* depending on whether the plants increase or decrease when a site is heavily grazed. When overuse on a site is continuous, the decreasers begin to be eliminated. Decreasers are generally the most palatable and most productive grasses. Although the increasers are also palatable, they are not so palatable as the decreasers, and they begin to move into the heavily grazed areas and to replace the decreasers. Then the livestock turn to the increasers, and they begin to decline. As the range condition worsens, *invaders,* or plants not native to the site, take the place of the better plants. Generally, invaders are less palatable and less productive than other plants, and their yields of forage are less reliable.

Thus, if a range site is overgrazed continuously, the composition of the vegetation changes from the best to the poorest. These successive changes are identified as range condition class. The condition class of a range is determined by comparing the kinds and amounts of present plants with the kinds and amounts of plants in the potential, or the climax, vegetation. The climax vegetation can be determined by comparing the plants on the individual soils in undisturbed areas, or areas excluded from grazing, with the plants on the same kinds of soils in areas having known records of grazing. A study of past records and of ecological or botanical literature may be helpful. The range condition is *excellent* if the percentage of the original, or climax, plants is more than 75. It is *good* if this percentage is 50 to 75, *fair* if the percentage is 25 to 50, and *poor* if the percentage is less than 25. The range condition is determined so as to provide an estimate of the deterioration that has taken place and to provide a basis for planning the management needed to improve the range. Most of the range in the county is presently in fair or poor condition.

Descriptions of range sites

In this subsection the twelve range sites in Kinney County are described and the composition of the climax vegetation is given in terms of decreasers, increasers, and invaders. Then the range condition of the site is discussed. The predicted yield of total herbage is given for each site when it is in excellent condition. Herbage from woody plants is not included in predicted yields.

The names of the soil series represented in each range site are mentioned in the description of each site, but this does not imply that all the soils of a given series appear in the range site.

ANACACHO HILL RANGE SITE

Only the Ector soils mapped in a complex with Rock outcrop are in this range site. This complex is in the southeastern part of the county on rolling hills and ridges in the Anacacho Mountains. It consists of very shallow, stony soils that are underlain by limestone at a depth of only 3 to 10 inches (fig. 7). In many places on this site are

limestone boulders and stones as much as several feet in diameter. The soils take in water at a moderate rate, but they hold only a small amount of it. Although the water from small rains enters the soil, runoff from heavy rains is rapid. Soil erosion is severe in areas where the vegetation is sparse.

Figure 7.—Ridges and steep side slopes in an area of Ector-Rock outcrop complex on the Anacacho Mountains. Anacacho Hill range site.

The soils in this range site are fertile and support many kinds of grasses and woody perennials. Overgrazed areas generally improve rapidly if grazing is controlled because sees are scattered from better plants growing in rock crevices and not accessible to grazing animals.

Prominent in the climax, or potential, vegetation are mid and short grasses and a variety of perennial forbs and woody plants. About 55 percent of this vegetation consists of decreasers that include sideoats grama, feathery bluestem, green sprangletop, plains lovegrass, Texas cupgrass, and Texas wintergrass. Approximately 45 percent consists of increasers that include fall witchgrass, spike bristlegrass, curly mesquite, slim tridens, hairy grama, and perennial three-awn. The perennial forbs are Englemann daisy, gaunt, perennial evening primrose, vetch, bundleflower, penstemons, prairie acacia, and claims. The woody plants are guajillo, kidneywood, vine ephedra, bush sunflower, sticky selloa, orange zexmenia, and Texas bauhinia. Among the invading grasses are red grama Halls panicum, hairy tridens, and purple three-awn. Also invading are annual forbs and annual grasses, as well as persimmon, catclaw, blackbrush, whitebrush, coyotillo, leatherstem, and cactus.

Most of the acreage is in poor or fair condition. Formerly the site deteriorated because it was heavily grazed by goats and sheep. First to be grazed off were the decreasers—sideoats grama, feathery bluestem, plains lovegrass, and Texas wintergrass. The goats removed many of the better forbs. During the past few years, however, the range has stabilized. Most areas are now covered with thick stands of blackbrush, leatherstem, and pricklypear cactus.

Forage plants on the Ector soils respond well to proper range use and deferred grazing.

When this site is in excellent condition, it can produce annually an estimated 2,100 pounds of air-dry herbage per acre. In less favorable years, the site can produce only 1,000 pounds per acre.

CLAY FLAT RANGE SITE

This range site consists of nearly level, deep, dense, gray, calcareous clays of the Montell series. These soils shrink during dry periods and swell during wet periods.

When these soils dry, wide, deep cracks form that readily take in water from heavy rains. When the rains wet the soils, however, the cracks close and water enters the soils slowly. Runoff is generally slow because these soils are level or nearly level. Light showers are ineffective because the large amount of clay impedes entry of water into these soils. Grasses are needed that can withstand extremes in wetness and dryness. This site is fairly productive because it is in broad, level or nearly level areas, is naturally fertile, and has high water-holding capacity. Because the heavy clays in this site are droughty, revegetation of the native grasses is difficult after the original grasses have been destroyed.

The climax vegetation is dominantly pink pappusgrass, cane bluestem, vine-mesquite, white tridens, tobosa, curly mesquite, and spike bristlegrass. In lesser amounts are Arizona cottontop, fall witchgrass, and Rio Grande lovegrass. Alkali sacaton is particularly important in the lower lying areas. Among the invaders are red grama, whorled dropseed, sand dropseed, and annual weeds. This site was a prairie on which mesquite was the principal woody invader, but drought has killed the mesquite in some areas. Other invaders are lotebush, whitebrush, and spiny hackberry. The same kinds of perennial forbs do not grow on this site as grow on the other sites in the county but velvet bundleflower is an important legume.

The condition of this site is fair in most areas and good in a few (fig. 8). The range has been stable during the past 10 years. Under heavy grazing, cane bluestem white tridens, tobosa, spike bristlegrass, and other tall grasses are first to be removed from the site. Then curly mesquite and other short grasses are dominant in overgrazed areas. Mesquite invades many areas.

Figure 8.—Nearly level areas of Montell clay that have been improved through proper use. Clay Flat range site in good condition.

Forage plants on this site respond to brush control, proper use, and deferred grazing. Where trees and brush are dense, forage production can be improved by eradicating the undesirable plants with chemical sprays or by mechanical methods. Then the range can be rested or grazing deferred so that the grasses can grow. Water for livestock is furnished on these soils by ponds.

When this site is in excellent condition, it can produce annually an estimated 3,400 pounds of air-dry herbage per acre. In less favorable years, the site can produce 1,500 pounds per acre.

CLAY LOAM RANGE SITE

This range site consists of broad, level to gently sloping areas of Gila, Glendale, Knippa, and Uvalde soils. These soils are deep, friable to firm, calcareous, and loamy or clayey. They generally take in water at a moderate rate and can hold a large amount of it. A thick crust that greatly slows the intake of water forms on the surface of these soils in areas where cover is depleted. These soils are only slightly susceptible to erosion. They are naturally fertile and support a mixture of deep, well-rooted perennial bunchgrasses and sod grasses.

The climax, or potential, vegetation of this site consists of cane bluestem, sideoats grama, twoflower trichloris, lovegrass tridens, Arizona cottontop, plains lovegrass, buffalograss, curly mesquite, pink pappusgrass, spike bristlegrass, tobosa, perennial three-awn, and fall witchgrass. In the lower lying areas of deeper soils the plant cover includes vine-mesquite, tobosa, and white tridens. Invading plants are red grama, annual weeds and grasses, mesquite, whitebrush, condalia, spiny hackberry, blackbrush, and guayacan. Pricklypear cactus commonly grows in thick stands and is a problem.

Most of the acreage of this site is in poor condition that is slowly becoming poorer. Most of the deterioration results from heavy grazing by cattle and sheep. The taller decreaser grasses and forbs have been replaced mainly by invaders and increasers. Mesquite, whitebrush, blackbrush, and other brush are especially thick.

Forage plants on all soils in this site respond readily to brush control, proper use, range seeding, or other needed practices of management. Where trees and brush are dense on the Knippa soil, forage production can be improved by eradicating the undesirable plants with chemical sprays or by mechanical methods. Then the range can be rested or grazing deferred so that the grasses can grow.

On the Glendale and Gila soils, water for livestock is generally available in the spring-fed streams. Windmills and shallow wells also may be used. On the Knippa soil, water for livestock is supplied by windmills and ponds. Windmills also supply water on the Uvalde soil. A few ponds have been built on the Uvalde soil, but excessive seepage generally prohibits their use.

When this site is in excellent condition, it can produce annually an estimated 3,800 pounds of air-dry herbage per acre. In less favorable years, the site can produce only 1.700 pounds per acre.

GRAVELLY RIDGE RANGE SITE

This range site consists of Jimenez, Zapata, and Quemado soils. These soils are on gently undulating to rolling ridges in the southwestern part of the county along breaks that extend to the Rio Grande. The soils are very shallow gravelly loams that are underlain by hard caliche at a depth of 3 to 15 inches. Their soil material is of a mixed origin and includes particles of quartz, sandstone, basalt, and limestone. Because the water-holding capacity of these very shallow soils is low, grasses on them are more widely spaced than they are on some of the deeper soils. In some places roots of plants enter the underlying caliche, and as a result, yields of some plants are fair. The soils in this site use the water from small showers very well, but runoff from the heavy rains is very rapid. A gravelly pavement forms in overgrazed areas, where the vegetation is very thin. Because of this pavement, more water is lost in runoff and droughtiness increases. Soil erosion is a problem in places.

The climax vegetation consists of cane bluestem, sideoats grama, Arizona cottontop, lovegrass tridens, tanglehead, spike bristlegrass, slim tridens, fall witchgrass, reverchon panicum, curly mesquite and perennial three-awn. Guajillo normally makes up about 15 percent of the plant cover. Many species of perennial forbs are significant on this site. In misused areas, the main invaders are red grama, hairy tridens, purple three-awn, and annual grasses and forbs, as well as cenizo,

blackbrush, paloverde, condalia, false mesquite, spiny hackberry, and other woody shrubs.

This site has generally stabilized and is in fair condition in most places. Formerly, cattle and sheep overgrazed the site and removed most of the better grasses and forbs. The grasses common on the site are curly mesquite, three-awns, and red grama. In the thicker areas of brush, cenizo and blackbrush are the main plants.

The response to brush control, deferred grazing, and proper use is better on the Quemado soils than on the other soils in this range site.

When this site is in excellent condition, it can produce annually an estimated 2,100 pounds of air-dry herbage per acre. In less favorable years, it can produce only 1,000 ponds per acre.

LOAMY BOTTOM LAND RANGE SITE

This range site consists of nearly level to gently sloping areas of Pintas and Frio soils. These soils are on flood plains along rivers, creeks, and springs and are deep, friable, calcareous, and loamy. They receive some extra water from floods, and they hold a large amount of it. These soils are naturally fertile and are highly productive. In places where a water table is within reach of plant roots, large live oak and pecan trees grow.

Since the soils are near water, plants near watering places and in shady spots under large trees are easily overgrazed by animals. The site is suitable for the grazing of sheep, cattle, and goats. Wildlife is abundant. The large trees and the understory of brush provide cover and food for turkeys, deer, and other kinds of wildlife.

The climax, or potential, vegetation consists mainly of grasses, but live oaks, pecans, and other trees grow in motts where moisture is favorable. The grasses and shrubs are fourflower trichloris, sacaton, southwestern bristlegrass, Arizona cottontop, feathery bluestem, vine-mesquite, white tridens, curly mesquite, buffalograss, spike bristlegrass, and pink pappusgrass. In overgrazed areas the invading plants are fall witchgrass, red grama, three-awns, hooded windmillgrass, whorled dropseed, annuals, mesquite, whitebrush, retama, spiny hackberry, and condalia.

This site is in good to excellent condition along Las Moras and other creeks in the southern part of the county. Mainly cattle have grazed these areas. In the northern part of the county, along the West Nueces River and other streams, this site is in poor condition and is continuously deteriorating because it is heavily grazed by all kinds of livestock and many deer. Livestock have grazed and trampled the vegetation near the watering places, so that almost all the grasses are gone and brush and trees are thick.

On all the soils in this site, forage plants respond readily to brush control, proper use, or other needed practices of management (fig. 9). In some areas of Frio soil, thick stands of trees and brush need to be controlled by mechanical or by chemical methods so that the stands of native grasses improve. On the Frio soil, water for livestock is generally available in the spring-fed streams. Windmills are needed for supplying water in some pastures.

When this site is in excellent condition, it can produce annually an estimated 5,300 pounds of air-dry herbage per acre. In less favorable years, the site can produce only 3,500 pounds per acre.

Figure 9.—Loamy Bottom Land range site. Top: Good stand of sacaton on Pintas silty clay loam along Las Moras Creek. *Bottom:* Area of Frio clay loam that was heavily infested with mesquite before it was root plowed and then seeded to blue panicum.

LOW STONY HILL RANGE SITE

This range site consists of Tarrant and of Ector soils mapped in a complex with rock outcrops. These soils are on very broad, undulating to rolling hills and ridges in the northern half of the county. These soils are dark-colored, friable stony clays and loams that are very shallow over limestone. Slopes range from 1 to 20 percent. These soils have a moderate intake rate, but their water holding capacity is low. Small rains are effective, but much water is lost in runoff from heavy rains. Soil erosion is severe in areas that have a thin cover.

The soils in this site are fertile. They are very shallow, but deeper pockets of soil are in crevices and the horizontal cracks in the limestone. In the deeper pockets of soil, the taller grasses grow, but the more shallow areas support short grasses and forbs that mature rapidly.

Of the characteristic climax grasses, about 55 percent are decreasers and about 45 percent are increasers. The decreasers are mainly sideoats grama, little bluestem, green sprangletop, Texas cupgrass, plains lovegrass, and Texas wintergrass. The increasers include curly mesquite, fall witchgrass, slim tridens, buffalograss, hairy

grama, nealley grama, and perennial three-awn. Perennial forbs are important on this range site and generally make up about 5 percent of the plant composition. Among these plants are Englemann daisy, gaura, vetch, penstemon, bush sunflower, orange zexmenia, bundleflower, evening primrose, prairie clovers, daleas, and prairie acacia. Climax woody plants that make up as much as 10 percent of the vegetation are kidneywood, skunkbush, Mexican sagewort, black and feather dalea, evergreen sumac, and shin oak. Some live oak is native to areas of the Tarrant soils but is absent on the Ector soils. Invading plants include Halls panicum, red grama, hairy tridens, Texas grama, tumblegrass, purple three-awn, and annuals. The woody invaders are juniper, catclaw, persimmon, coyotillo, agarita, mescalbean, and cactus. On areas of Tarrant soils, stands of live oak are thick.

For many years this site has deteriorated. Most areas are now in poor condition (fig. 10), though the condition of some areas is fair. Deterioration results from overgrazing by sheep and goats, which have grazed off desirable forbs and grasses. Heavy grazing by goats has eliminated some of the oaks and has raised the browse line of the rest.

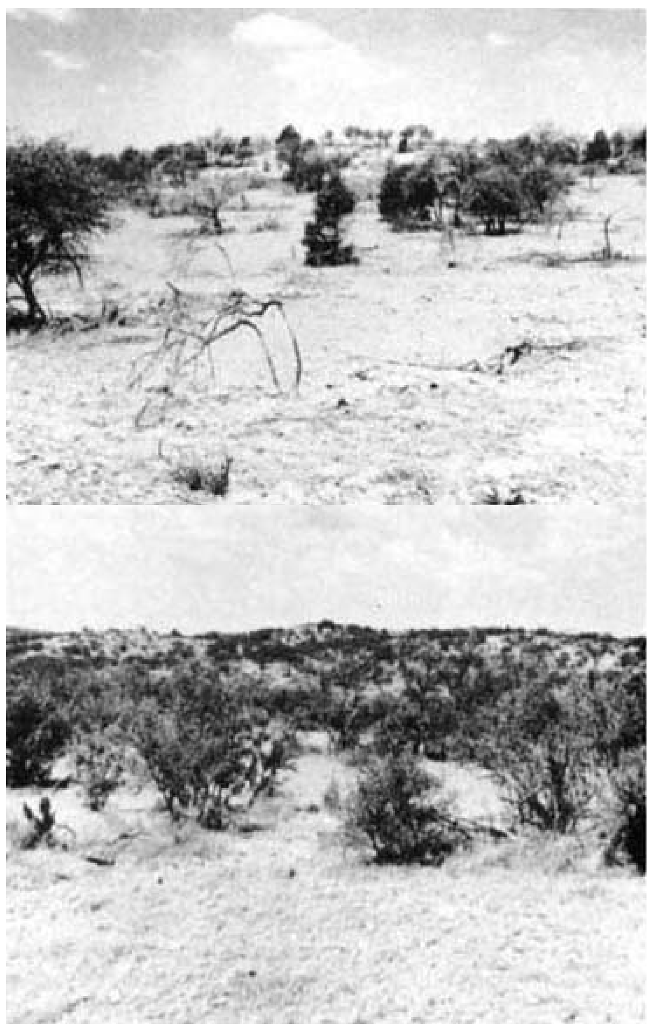

Figure 10.—Tarrant soils in the Low Stony Hill range site. Top: The site is in poor condition because the better grasses and forbs have been grazed out. Only red grama, three-awn, and other low-quality grasses remain. *Bottom:* The site is in fair condition. Curly mesquite, sideoats grama, feathery bluestem, and plains lovegrass make up the cover.

Except in steeper areas having large stones, forage plants on the Tarrant soils respond well to proper use, deferred grazing, or other needed practices of management (fig. 11).

Figure 11.—This Low Stony Hill site has been rested from grazing. The brush has been controlled, and the better grasses are crowding out the low producers. The area is of Tarrant soils.

When this site is in excellent condition, it can produce annually an estimated 3,000 pounds of air-dry herbage per acre. In less favorable years, the site can produce 1,700 pounds per acre.

OVERFLOW RANGE SITE

Only Dev soils are in this range site, which is made up of low ridges and swales parallel to stream channels. These soils are deep and very gravelly. They are on bottom land that is likely to be flooded frequently. Because these soils are gravelly and are likely to be damaged by floods, this site is not so productive as the Loamy Bottom Land range site.

The climax, or potential, vegetation consists mainly of grasses and forbs but includes some scattered bushes and trees. The decreasers are silver bluestem, southwestern bristlegrass, vine-mesquite, sideoats grama, and white tridens, as well as associated forbs such as bush sunflower, snout bean, and Englemann daisy. Where the site is overgrazed, the increasers are buffalograss, curly mesquite, plains bristlegrass, and Texas wintergrass. Plants that commonly invade are annual weeds and grasses, whitebrush, mesquite, and pricklypear cactus.

This site is in poor condition and continues to deteriorate slowly. It is severely overgrazed by all kinds of livestock because it is near water and has shaded areas. Invading plants of low quality are common.

Forage plants on this site respond to proper use and deferred grazing.

When this site is in excellent condition, it can produce annually about 3,200 pounds of air-dry herbage per acre. In years when rainfall is less than average, the site can produce only 1,200 pounds per acre.

SHALLOW RANGE SITE ON EDWARDS PLATEAU

Only the Kavett part of Kavett-Tarrant stony clays are in this range site.. The Kavett soils are in nearly level to gently sloping valleys in the northern part of the county. They are dark colored, well drained, and shallow over limestone. Slopes are generally less than 3 percent. These soils take in water at a moderate rate, and they hold a moderate amount of it. Some runoff water is received from surrounding areas of more steeply sloping, very shallow soils.

The climax, or potential, vegetation consists mainly of sideoats grama and feathery bluestems. Also present are smaller amounts of green sprangletop, Texas wintergrass, vine-mesquite, curly mesquite, fall witchgrass, slim tridens, and hairy grama. Forbs generally make up about 5 percent of the vegetation. Invading plants are red grama, hairy tridens, purple three-awn, annual weeds and forbs, live oak, mesquite, persimmon, agarita, lotebush, juniper, and catclaw.

Most of this site is in poor condition. The deterioration results mainly from heavy grazing by sheep and goats, but cattle and sheep add to the damage when they move from one part of the pasture to another. This heavy grazing and the trampling rapidly eliminate the decreasers.

On this site brush control, range seeding, proper use, and deferred grazing are more effective on the Kavett soils (fig. 12) than on the Tarrant.

Figure 12.—Shallow range site in good condition following brush control, range seeding, and proper use. The soil is Kavett stony clay.

When this site is in excellent condition, it can produce annually an estimated 3,200 pounds of air-dry herbage per acre. In less favorable years, the site can produce 1,700 pounds per acre.

SHALLOW RANGE SITE ON RIO GRANDE PLAIN

Only Reagan loam is in this range site. This moderately deep soil occurs on gently sloping to sloping ridges in the southern part of the county. It is grayish brown, friable, calcareous, and loamy. Water is taken in at a moderate rate and held by the soil in fair amounts. The hazard of erosion is moderate. This soil tends to be droughty because it is only moderately deep, but deep-rooted grasses grow well, except in long dry periods.

The climax vegetation consists of sideoats grama, Arizona cottontop, feathery bluestem, plains lovegrass, pink pappusgrass, spike bristlegrass, perennial three-awn, slim tridens, fall witchgrass, curly mesquite, and buffalograss. Guajillo grows in some areas. Common invaders are red grama, hairy tridens, Halls panicum, annual grasses, and annual weeds. The common woody invaders are mesquite, leatherstem, blackbrush, guayacan, catclaw, agarita, spiny hackberry, cactus, and lotebush.

For many years this site deteriorated, but in recent years most areas have been stabilized and are in fair condition. The deterioration resulted mainly from heavy grazing by cattle and sheep. Some overgrazed areas are heavily infested with mesquite.

On this site forage plants respond to brush control, range seeding, and proper use (fig. 13). Where mesquite and blackbrush have invaded overgrazed areas, brush can be controlled by root plowing, chaining, or applying chemical sprays. Then the range can be rested or grazing deferred so that the grasses can grow.

Water for livestock is generally pumped by windmills, but in a few selected places ponds can be built.

When this site is in excellent condition, it can produce annually an estimated 2,800 pounds of air-dry herbage per acre. In less favorable years, the site can produce 1,200 pounds per acre.

Figure 13.—Shallow range site on Rio Grande Plain. Reagan loam has been root plowed and planted to blue panicum and buffalograss.

SHALLOW RIDGE RANGE SITE

This range site consists of Kimbrough and Ector soils, mapped as a complex, and the Ingram soils on gently sloping to low rolling ridges or on hills of igneous rock. These soils are calcareous gravelly loams that are underlain by hard caliche or limestone at a depth of less than 10 inches. Slopes range from 0 to 8 percent. These soils have a moderate intake rate but a very low capacity for holding water. Small rains are effective, but much of the water from heavy rains is lost in the rapid runoff. Soil erosion is a problem where cover is thin.

The dominant plants in the climax vegetation are sideoats grama, green sprangletop, and feathery bluestem. Other plants are Arizona cottontop, spike bristlegrass, slim tridens, fall witchgrass, hairy grama, hairy tridens, and perennial three-awn. About 15 percent of the increasers are woody plants and include guajillo, kidneywood, feather dalea, and vine ephedra. Live oak grows at the head of streams and in the more moist areas. Invading plants are red grama, red three-awn, annual weeds, annual grasses, and woody plants. Amongthe woody plants are blackbrush, catclaw, cenizo, pricklypear cactus, leatherstem, mesquite, and condalia. The low brush and pricklypear are thick. The percentage of woody plants is higher on the Ingram soils than on the other soils in this site.

Most of this site is in poor or fair condition. The deterioration, which is continuing, results mainly from heavy grazing by cattle and sheep. Pricklypear cactus is a problem in some overgrazed areas (fig. 14). A thin stand of red grama, three-awns, and other grasses, along with guajillo, cenizo, and other brush, grows in other overgrazed areas.

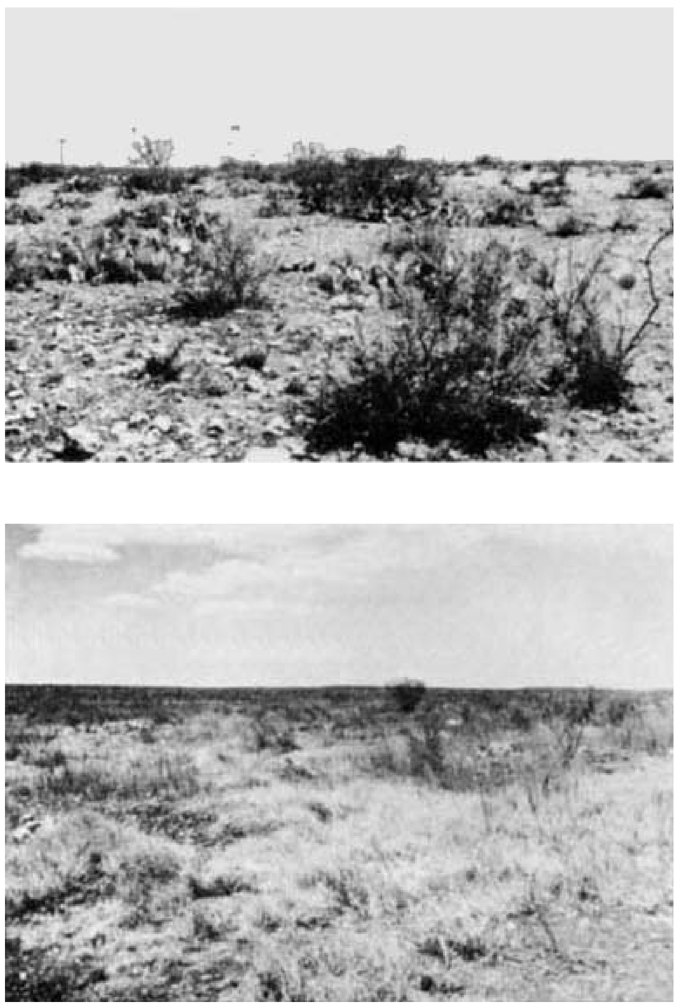

Figure 14.—Kimbrough soils in Shallow Ridge range site. Top: The site is in poor condition because the better grasses have been grazed out and pricklypear cactus has invaded. Bottom: The site is in good condition after proper grazing was applied. The better grasses on this site are green sprangletop and sideoats grams.

Forage plants on all soils in this site except the Ingram soils respond readily to brush control, proper use, deferred grazing, or other needed practices of management.

When this site is in excellent condition, it can produce annually 2,600 pounds of air-dry herbage per acre. In less favorable years, the site can produce only 1,400 pounds per acre.

STEEP ROCKY RANGE SITE

Limestone rockland, the only mapping unit in this range site, is very steep and stony. It is mostly limestone that has dark grayish-brown to black clay in pockets and crevices. Slopes are generally about 35 percent but range from 20 to 70 percent. Ledges and outcrops of limestone cover about 20 percent of the surface, and the spaces between the ledges and outcrops are mostly covered by stones and boulders. In some places soil extends in pockets to a depth of more than 2 feet and also is in horizontal fractures of the limestone.

The soil material is fertile, and the response of plants to good management is good. The water from small showers is used well, for it runs off the rocks and boulders and enters the soil-filled cracks and crevices. Tall bunchgrasses and woody perennials are especially benefited by this additional moisture. Because rapid runoff from heavy rains is common on this site, the soil erodes readily where it is not, protected by rocks or vegetation.

Decreasers make up about 55 percent of the climax vegetation. The decreasers are sideoats grama, little bluestem, green sprangletop, plains lovegrass, Texas cupgrass, Texas wintergrass, tall dropseed, and forbs. Increasers account for 45 percent of the climax vegetation. They are tall grama, hairy grama, fall witchgrass, slim tridens, perennial three-awn, forbs, and woody plants. Perennial forbs are significant because they are nutritious. Included among the forbs are Englemann daisy, guara, bush sunflower, orange zexemenia, penstemons, bundleflower, perennial evening primrose, vetch, and daleas.

Among the woody plants on this range site are kidneywood, skeletonleaf goldeneye, skunkbush, evergreen sumac, sticky selloa, feather and black daleas, vine ephedra, live oak, and shin oak. Invading plants include grasses, forbs, and woody plants. These invaders are red grama, Halls panicum, hairy tridens, purple three-awn, Texas grama, tumblegrass, annual forbs, annual grasses, juniper, persimmon, mescalbean, catclaw, coyotillo, and cactus.

For many years this range site has deteriorated, but in recent years many areas have stabilized and are in fair and poor condition. The better grasses and forbs have been removed, mainly by the heavy grazing of goats and sheep. Among the plants that were first removed are little bluestem, sideoats grama, green sprangletop, Texas cupgrass, kidneywood, Englemann daisy, and skunkbush. Ashe juniper has invaded in large areas (fig. 15).

On this site forage plants respond readily to deferred grazing and proper use.

VEGA RANGE SITE

This range site, which consists of only Alluvial land, is on gently undulating to slightly ridged bottom land along the Rio Grande. The soil material is friable and loamy. It is productive because it receives extra water from floods and a high water table.

The climax, or potential, vegetation on this site is not known, but it probably consists of sacaton, common reedgrass, switchgrass, trichloris, and other grasses. Willows, cottonwood, baecharis, and other woody plants and forbs are grown on this site.

Figure 15.—Limestone rockland in an overgrazed area of Steep Rocky range site. Ashe juniper has invaded. Water erosion is active.

Giantreed, a tall, canelike grass, has invaded the site and now dominates the plant cover. Some bermudagrass and blue panicgrass grow in open areas. Annual weeds are prevalent.

This site is in good or excellent condition, mainly because it has been stabilized by the giantreed. Most of the grazing animals are cattle.

When giantreed has invaded and dominates the site, the average annual yield of air-dry herbage is 12,000 pounds per acre. When mixed vegetation on this site is in excellent condition, the site can produce annually an estimated 5,300 pounds of air-dry herbage per acre. In less favorable years, it can produce only 3,500 pounds.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest grouping, are designated by Roman numerals I through VIII. As the numerals increase, they indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I. Soils have few limitations that restrict their use.

Class II. Soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III. Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV. Soils have very severe limitations that restrict the choice of plants, require very careful management, or both.
Class V. Soils subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.
Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.
Class VII. Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.
Class VIII. Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in the county.)

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e, w,* s, or c, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w, s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough a like to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIs-1 or IIIe-1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral specifically identifies the capability unit within each subclass.

All the soils in Kinney County are placed in nonirrigated capability units, and those soils suitable for irrigation are also placed in irrigated capability units. For this reason, a few soils are in nonirrigated and irrigated units. Both kinds of units are discussed in the following pages.

Management of nonirrigated capability units

In this subsection the nonirrigated capability units in Kinney County are described, and suggestions for use and management of the soils are given. The rainfall is so low that none of the soils in the county are in class I, II, or III unless they are irrigated.

The names of the soil series represented in each capability unit are mentioned in the description of the unit, but this does not mean that all the soils of a given series appear in the unit.

CAPABILITY UNIT IVc-1 (NONIRRIGATED)

This unit consists of deep, friable Frio, Gila, and Glendale loamy soils. These soils are nearly level, light brownish gray to very dark grayish brown, and moderately

permeable. They occur on the flood plains of rivers and creeks and are occasionally flooded in some places. Yields are severely limited by lack of rainfall in most years. Drainage is good, and natural fertility is high.

The soils in this unit are used mainly as range. Some areas are used for oats, for pasture consisting of tame grasses, and for other forage crops. These soils are suited to all of these uses.

The soils in this unit require management that helps to maintain the content of organic matter and to conserve moisture. On small fields planted to crops or on tame pastures, enough grass or residue from small grain should be left on the surface to maintain the content of organic matter. This practice is helpful in keeping the surface from crusting and in allowing more rainfall to enter the soil. In some areas farming on the contour is needed to help keep the rain where it falls. A grassed waterway is needed in a few places where water from other areas flows across these soils. Establishing grasses in the waterway is difficult because the climate is dry.

The Gila and Glendale soils are in the Clay Loam range site, and the Frio soil is in the Loamy Bottom Land range site.

CAPABILITY UNIT IVc-2 (NONIRRIGATED)

Only Uvalde silty clay loam is in this unit. This soil is deep, dark grayish brown, nearly level, friable, well drained, and moderately permeable. It is on broad, smooth uplands, mainly in the southern two-thirds of the county. Natural fertility and available water capacity are high. The hazard of erosion is slight.

This soil is used mainly as range because yields in dryfarmed areas are severely limited in most years by lack of rainfall. Some areas are used for oats and other forage crops and for pasture consisting of tame grasses. These uses are suitable.

This soil requires management that helps to maintain the content of organic matter and to conserve moisture. On small fields in crops or tame pasture, enough grass or residue from small grain should be left on the surface to maintain the content of organic matter. This practice also helps in preventing crusting of the surface and in allowing the rainfall to enter the soil. Farming on the contour is desirable in places because it helps to keep the rain where it falls. For controlling water from other areas, grassed waterways are needed in a few places.

This soil is in the Clay Loam range site.

CAPABILITY UNIT Vs-1 (NONIRRIGATED)

This unit consists of deep, friable to firm, moderately well drained and well drained Knippa and Montell soils. These soils are gray to grayish-brown clays or silty clays that occur in broad, smooth, nearly level areas, mainly in the southern part of the county. When dry, these soils crack and take in water rapidly, but the cracks close when the soils are wet, and water is then taken in slowly. Natural fertility and capacity to hold water are high. Runoff is very slow, and erosion is not a problem.

Because the climate is dry, the soils of this unit are not suitable for dryfarming; they are suited to native grasses. Yields of native grasses are fair. Careful management is needed that helps in maintaining the content of organic matter and in conserving moisture. These soils are easy to manage. Some areas provide sites for farm ponds and suitable habitats for wildlife.

The Knippa soil is in the Clay Loam range site, and the Montell soils are in the Clay Flat range site.

CAPABILITY UNIT Vw-1 (NONIRRIGATED)

Only Pintas silty clay loam is in this unit. This friable soil is moderately deep, moderately well drained, dark colored, and calcareous. It is on bottom land that is subject to flooding. Natural fertility is high, but the use of this soil is restricted

because flooding is a hazard. The water table of this soil fluctuates between 3 and 10 feet of the surface.

Areas of this soil that are not protected from flooding are better suited as range or as wildlife habitats than they are to other uses. Areas protected from flooding require about the same management as the soils in capability unit IVc-1 (nonirrigated).

This soil is in the Loamy Bottom Land range site.

CAPABILITY UNIT Vw-2 (NONIRRIGATED)

Only Alluvial land is in this unit. It consists of well-stratified sandy loams and silt loams that are deep, friable, and light colored. It is frequently flooded by water from the Rio Grande. Most of the time water stands in sloughs and other low areas. Scour channels and saline spots are common. Damaging floodwaters remove soil material from some parts of this land and deposit new material in other parts. Subirrigation is common in many places.

Alluvial land is suited to crops only if flooding is controlled. It requires management that helps to minimize damage from flooding. This damage can be lessened by maintaining vigorous, healthy giantreed or bermudagrass and by controlling grazing.

Where this land is protected from flooding, it can be managed the same as the soils in capability unit IVc-1 (nonirrigated) and in capability unit I-1 (irrigated).

This land type is in the Vega range site.

CAPABILITY UNIT VIs-1 (NONIRRIGATED)

Only Reagan loam is in this unit. This moderately deep soil is light colored, friable, well drained, and moderately permeable. It is on gently sloping foot slopes in the Anacacho Mountains and is on breaks that extend to creeks in the southwestern part of the county.

Natural fertility and available water capacity are moderate. 'Water erosion is a moderate hazard.

This soil is so dry that it is not suitable for dryfarming; it is used as range. Management is required that helps in maintaining the content of organic matter and in controlling erosion and conserving moisture.

This soil is in the Shallow range site on the Rio Grande Plain.

CAPABILITY UNIT VIs2 (NONIRRIGATED)

Ingram stony clay is the only soil in this unit. This shallow, dark-brown soil formed from weathered basaltic rocks in strongly sloping areas, locally called mountains. Although this soil is fertile, it can hold only a small amount of water. It is highly susceptible to water erosion.

Because this soil is stony and strongly sloping, it is not suited to crops; it is suited as range.

This soil is in the Shallow Ridge range site.

CAPABILITY UNIT VIs-3 (NONIRRIGATED)

In this unit are Tarrant soils that are mapped as an undifferentiated unit and in complexes with Kavett soil and rock outcrops. The soils in this capability unit are gently sloping to hilly. They are dark-colored stony clays that are very shallow over hard limestone. They have low water-holding capacity but are highly susceptible to water erosion.

These soils are well suited as range but are not suited to crops. They require management that helps to maintain the content of organic matter and to control erosion and conserve moisture. A grass cover is effective in controlling runoff and erosion and improving the soil (fig. 16).

The Tarrant soils are in the Low Stony Hill range site, and the rock outcrop is not assigned a capability unit or range site.

Figure 16.—Grasses on right of fence Improved as a result of deferred grazing or proper grazing. Tarrant soils.

CAPABILITY UNIT VIs-4 (NONIRRIGATED)

Only a Kavett soil, mapped in a complex with a Tarrant soil, is in this capability unit. This Kavett soil is a stony clay that is underlain by limestone. It is dark colored and well drained. This soil is in the northern part of the county in nearly level to gently sloping valleys. It is fertile but has low water-holding capacity.

Because this soil is stony, it is not suited to crops; it is well suited as range. Management is required that conserves moisture and helps to maintain the content of organic matter. A grass cover is effective in controlling runoff and in improving the soil.

The Kavett soils are in the Shallow range site on Edwards Plateau.

CAPABILITY UNIT VIw-1 (NONIRRIGATED)

Only Dev soils are in this unit. These deep, dark-colored, very gravelly soils are on bottom land and are frequently damaged by floods that deposit and remove soil material.

These soils are so gravelly and so susceptible to flooding that they are not suited as cropland. Management is needed that prevents or limits damage from flooding and that helps to maintain the content of organic matter. A grass cover is effective in controlling damage caused by most floods, but a severe flood occasionally removes grass, trees, and soil from some areas and covers other areas with debris.

These soils are in the Overflow range site.

CAPABILITY UNIT VIIs-1 (NONIRRIGATED)

This unit consists of soils in the Ector series that are mapped in a complex with rock outcrops and also as an undifferentiated unit of Ector soils. These grayish-brown soils are stony and rocky, very shallow, and strongly calcareous. They are in hilly areas of the Anacacho Mountains and in undulating to hilly areas in the northwestern part of the county. These soils have low water-holding capacity and are highly susceptible to water erosion.

The soils in this unit are not suited to crops but are well suited as range. A grass cover is effective in improving the soil and in controlling runoff and erosion. Management is needed that conserves moisture and helps to maintain the content of organic matter.

The Ector soils mapped in a complex with rock outcrops are in the Anacacho Hill range site. The Ector soils mapped as an undifferentiated unit are in the Low Stony Hill range site. The rock outcrop is not assigned a capability unit or range site.

CAPABILITY UNIT VIIs-2 (NONIRRIGATED)

In this unit are the Jimenez and Zapata soils and the Kimbrough and Ector soils mapped as soil associations. Also in the unit are Kimbrough soils and Quemado soils mapped as undifferentiated units. The soils in this capability unit are very shallow and friable. They have low available water capacity. Most areas are susceptible to water erosion.

These soils are so gravelly and so shallow over caliche that they are not suited to cultivated crops. Even where used for pasture, these soils require management that helps in maintaining the content of organic matter. Also needed are practices for conserving moisture and controlling erosion. A grass cover is effective in improving the soils and in controlling runoff and erosion. Areas in native grasses and forbs require careful management.

The Jimenez, Zapata, and Quemado soils are in the Gravelly Ridge range site. The Kimbrough and Ector soils mapped as a soil association are in the Shallow Ridge range site.

CAPABILITY UNIT VIIs-3 (NONIRRIGATED)

Only Limestone rockland is in this unit. It is steep and stony and its soil material is very shallow over limestone.

This land type is highly susceptible to water erosion, though it is suitable for limited grazing. Because overgrazed areas erode quickly, careful management of livestock is required.

This soil is in the Steep Rocky range site.

Management of irrigated capability units

In this subsection the irrigated capability units in Kinney County are described, and suggestions for use and management of the soils are given.

CAPABILITY UNIT I-1 (IRRIGATED)

This unit consists of deep, friable Frio, Gila, and Glendale loamy soils. These nearly level, moderately permeable soils are light brownish gray to very dark grayish brown. They occur on the flood plains of the rivers and creeks and are occasionally flooded in places. Generally, the flooding does not cause much damage. These soils hold moderate or large amounts of available water. Natural fertility is high, and productivity is favorable.

The Gila and Glendale soils are suited to irrigated cotton, corn, sorghums, vegetables, improved pecans, and grapes. A small acreage of the Frio soil is planted to irrigated sorghums, alfalfa, bermudagrass, and vegetables. All of these soils are suited to irrigated bermudagrass.

Management is required that maintains or improves productivity and tilth and that provides efficient handling of water. By keeping crop residue at or near the surface, moisture is held for the use of crops. Cover crops help to maintain soil productivity and tilth. A grassed waterway is needed in places to carry water from other areas across these soils.

These soils are suitable for surface or sprinkler irrigation, depending on the smoothness of the land, the cost of leveling, the kinds of crops, and other factors. In most places pipelines or lined ditches are needed to deliver the water to the field because these permeable soils lose much water if open ditches are used. The irrigation water used on the Glendale and Gila soils comes from the Rio Grande, or

from artesian springs along some of the larger creeks. Wells drilled deep in strata of limestone supply the irrigation water used on the Frio soil.

CAPABILITY UNIT I-2 (IRRIGATED)

Only Uvalde silty clay loam is in this unit. This deep, dark grayish-brown, friable soil is moderately permeable. It is in nearly level areas on broad, smooth uplands, mainly in the southern two-thirds of the county. It has high natural fertility and high capacity to hold water.

On this soil suitable irrigated crops are sorghums, alfalfa, bermudagrass, and vegetables.

Management is needed that provides efficient handling of water and that maintains or improves productivity and tilth. Planting cover crops is one way to help maintain productivity and tilth. All crop residue should be kept at or near the surface.

This soil is suitable for either surface irrigation or sprinkler irrigation, depending on the lay of the land, the cost of leveling, the kinds of crops, and other factors. The irrigation water comes from wells drilled deep in limestone strata. In most places pipelines or lined ditches are needed to deliver the water to a field because this permeable soil loses much water in open ditches.

In places a grassed waterway is needed to carry water from surrounding areas across this soil. Also, a diversion terrace is needed on the upper sides of some fields so that water can be diverted around the leveled irrigated fields.

CAPABILITY UNIT IIs-1 (IRRIGATED)

This unit consists of deep, gray to grayish-brown Knippa and Montell soils that are moderately well drained and well drained. These soils are clayey and occur in broad, smooth, nearly level areas, mainly in the southern part of the county. They crack when they are dry, and they swell and heave when they are wet. These soils take in water slowly but can hold a large amount. Natural fertility is high. Runoff is very slow, and erosion is not a problem.

These soils are suited to irrigated cotton, sorghums, bermudagrass, and vegetables. The Knippa soil is also suited to corn. The Montell soil is not so well suited to carrots and potatoes as the Knippa soil.

The soils in this unit require management that maintains or improves soil productivity and tilth, provides efficient handling of water, and provides cropping systems suited to the soils. All crop residue should be kept at or near the surface.

Surface irrigation is used on these soils, but in some places a sprinkler system may be desirable. Irrigation water is supplied by wells drilled deep in strata of limestone. Specially designed underground pipelines and limed surface ditches are needed to withstand the swelling and heaving of the soils. In some places corrosion of metal pipelines is a problem. Because these heavy, clayey soils heave, leveling is needed on some fields every year or every 2 years.

Surface drainage is needed in places to prevent the excessive water from standing on the soil for several days. Where the Montell clay is waterlogged, its salinity may slowly increase because of the soluble salts in the underlying material. These salts go into solution, rise to the surface, and are deposited when the water evaporates. The excessive salts cannot be leached from this soil by applying a large amount of irrigation water.

Diversion terraces and grassed waterways are needed in places for controlling the water that comes from surrounding areas.

CAPABILITY UNIT IIIe-1 (IRRIGATED)

Only Reagan loam is in this unit. This soil is moderately deep, well drained, light colored, friable, and calcareous. It is in gently sloping areas in the uplands.

Permeability is moderate, and the capacity to hold water is medium. This soil is moderately susceptible to water erosion.

On this soil suitable irrigated crops are cotton, sorghums, alfalfa, bermudagrass, and vegetables.

Management is needed that maintains or improves productivity and tilth, controls erosion, and provides efficient handling of water. Planting cover crops on this soil is one way to help maintain productivity. All crop residue should be kept at or near the surface.

This soil is suitable for either surface irrigation or sprinkler irrigation, depending on the lay of the land, the cost of leveling, the kinds of crops, and other factors. The irrigation water comes from deep wells drilled in the limestone. Pipelines or lined ditches generally are needed to deliver the water to a field because this permeable soil loses much water in open ditches.

In places a grassed waterway is needed to carry water from other areas across this soil. Also, a diversion terrace is needed on the upper sides of some fields so that water can be diverted around leveled irrigated fields.

CAPABILITY UNIT IIIs-1 (IRRIGATED)

Only Montell clay, low, is in this unit. This somewhat poorly drained to moderately well drained soil is deep, dark gray, firm, and slightly saline to strongly saline. It is in smooth areas along poorly defined draingeways in the southern part of the county. This soil cracks when it is dry, and it swells and heaves when wet. It has high capacity to hold water, but it takes in water slowly. Because of the salinity, only salt-tolerant plants can use water from below a depth of 2 feet. Natural fertility is moderate to high. Runoff is very slow, and erosion is not a problem.

Areas of this soil that are only slightly saline are suited to irrigated cotton, sorghums, Coastal bermudagrass, and alfalfa. The strongly saline areas are not suited to irrigated crops.

This soil requires management that maintains or improves productivity and tilth, that provides efficient handling of water, and that provides cropping systems suited to the soil. All crop residue should be kept at or near the surface of this soil.

This soil is suitable for either surface irrigation or sprinkler irrigation, depending on the lay of the land, the cost of leveling, the kinds of crops, and other factors, The irrigation water comes from wells drilled deep in the limestone strata. Underground pipelines and lined ditches that are specially designed are needed to withstand the swelling and heaving of the soil. Corrosion may be a problem if metal pipeplines are used. Because this heavy clay heaves, fields require periodic releveling in some places.

Surface drainage is needed in places to prevent water from standing on this soil for several days. In some waterlogged areas, the salinity at the surface increases because salts in the underlying material go into solution, rise to the surface, and are deposited as the water evaporates. The excess salts cannot be leached from this soil by applying large amounts of irrigation water. Diversion terraces and grassed waterways are needed in places to control water from other areas.

Predicted Yields on Irrigated Soils

Table 2 lists predicted yields of the principal crops grown in the county on irrigated soils at a high level of management. The estimates are based on yields on the same kinds of soils in nearby counties. Crops not listed in table 2 that are grown successfully on the same kinds of irrigated soils in adjoining counties are beans, sweetcorn, cucumbers, melons, spinach, peas, and Irish potatoes. Less than 1 percent of Kinney County is cultivated, but most of that acreage is irrigated.

Management at a high level on irrigated cropland and pasture provides the following:

1. A properly designed irrigation system.
2. Irrigation water applied according to the kind of soil and the need of the crop.
3. Use of crop residue for maximum cover of the soil.
4. Soil-improving and high residue producing crops in the cropping sequence.
5. Fertilization according to the need of the crop.
6. Good cultural practices, including insect control.
7. Proper grazing of pasture.

Use of Soils for Wildlife

By Joe J. McEntire, area conservationist, Soil Conservation Service, Uvalde, Texas.

In Kinney County the principal kinds of wildlife are whitetail deer, turkey, javelina, fox squirrel, dove, bobwhite quail, and scaled (blue) quail. The sandhill crane and many kinds of ducks winter in the county. Also present are raccoons, foxes, ringtail cats, beavers, skunks, and other furbearers. These animals have been of little economic value since World War II because fur prices declined. The predators commonly found are bobcats, coyotes, and a few mountain lions. Most farm and ranch ponds are stocked with channel catfish, black bass, bluegill, and redear sunfish. Fishing is excellent in the Rio Grande, where the most popular fish are channel catfish, Rio Grande perch, and black bass.

Soils that are suitable as cropland and rangeland are also suitable as wildlife habitat, and they can be managed for that use. So that this management can be suggested more easily, the soils in Kinney County are placed in wildlife suitability groups. The soils in each group are on about the same kind of landscape, and they can produce about the same kinds and amounts of vegetation suitable for wildlife food and cover. The groups, therefore, reflect differences in their capacity to support wildlife. All kinds of wildlife need food, cover, and water, though no two kinds have exactly the same requirements.

WILDLIFE SUITABILITY GROUP 1

This wildlife group corresponds to the Kimbrough-Ector-Uvalde association, which is shown on the general soil map. The soils are very shallow and shallow. In most areas they formed on caliche or limestone, but in small areas they formed on igneous rock. Internal drainage is medium, and runoff is medium to rapid. These soils are nearly level to rolling. The major soils are the Kimbrough and Ector, but Ingram, Jimenez, Zapata, and Quemado soils are also in this group.

These soils support a mixed stand of woody vegetation that consists mainly of mesquite, guajillo, live oak, Texas persimmon, pricklypear cactus, and condalia. Where grazing has not been heavy, the grasses are mainly sideoats grama, bluestem, green sprangletop, Arizona cottontop, slim tridens, and other mid grasses. Low-producing perennial grasses and annuals invade heavily grazed areas.

Browse and cover for deer are provided by guajillo on the shallow ridges, and by live oak along the drainageways. Deer use grasses in some seasons and many annual weeds that appear after effective rains. Few turkeys frequent areas of these soils because the areas lack watering places and large trees for roosting. Many areas have only sparse cover, and in some areas a decrease in the number of deer reflects the amount of cover available. Doves and quail find the soils in this group an ideal habitat, since food plants and nesting areas are available. These soils support a large amount of annual plants, especially croton, which doves and quail feed on from late in spring into winter. Because the soil material is very poor for the construction of

ponds, and there are no springs, most water for wildlife is available only at wells and watering places for livestock.

WILDLIFE SUITABILITY GROUP 2

This group is approximately coextensive with the Tarrant-Ector soil association, which is shown on the general soil map. It consists of shallow to very shallow soils that formed on limestone. These soils have medium internal drainage and medium to rapid runoff. They are in the northern part of the county at the higher elevations and are rolling to very steep. The major soils of this group are the Tarrant and Ector.

Much of this wildlife group is covered by a mixed stand of live oak, Ashe juniper, shin oak, Texas persimmon, and other woody plants suitable for browse. These plants provide excellent cover and some food for white-tail deer and turkey, Many kinds of mid grasses grow and provide forage for deer and seed for doves and quail. Among these grasses are sideoats grama, bluestem, green sprangletop, slim tridens, and plains lovegrass. Because they are rolling to very steep and are shallow or very shallow, the soils of this group are periodically droughty. This droughtiness favors the growth of annual grasses and forbs on which large numbers of doves and quail feed.

Water for deer, turkeys, and doves is provided by many small springs, rock basins in drainageways, and watering places for livestock. Javelina find suitable habitat and cover along the steeper areas where small caves and ledges are located, Pricklypear cactus is particularly adapted to these shallow soils and provides some food for javelina, but that plant is mostly a pest. On these soils ringtail cat, raccoon, and other furbearers also find plants that are especially suited to their needs.

WILDLIFE SUITABILITY GROUP 3

This wildlife group is in the Uvalde-Montell association, which is shown on the general soil map. It consists of deep to moderately deep soils that formed in calcareous material on the Rio Grande Plain. These soils are nearly level to gently sloping and have medium runoff and internal drainage. The major soils are the Uvalde and Reagan, but the Knippa soils are also in this group.

These soils provide productive habitats for many kinds of wildlife, including deer, dove, and quail. Many overgrazed areas are heavily invaded by brush, mostly mesquite. By competing for moisture, sunlight, and space, the mesquite reduces the growth of plants that wildlife prefer. Cover suitable for deer, and for other wildlife, can be left on these soils by controlling brush in selected patterns. By leaving the brush in strips, along drainage ways, and in other places a cover for escape is provided. This brush also provides nesting places for doves.

Root plowing and reseeding with blue panicum has been considerable on these soils. The seed of blue panicgrass provides excellent food for both quail and doves. Grasses valuable for their seed and for forage are side-oats grama, pink pappusgrass, fall witchgrass, bluestem, Halls panicum, vine-mesquite, and bristlegrass. Englemann daisy is an important forb both for its seed and for forage.

Cropped areas planted to grain sorghums or small grain provide food for doves and quail. These soils can easily be managed so that they produce larger numbers of wildlife.

WILDLIFE SUITABILITY GROUP 4

This group is in the Uvalde-Montell association, but it consists only of Montell soils. These deep, clayey soils are in broad, smooth, nearly level areas of the Rio Grande Plain. They have slow internal drainage and runoff. Moderately deep cracks form when these soils are dry. Below a depth of 2 feet these soils are slightly saline to strongly saline. Water ponds in small drainageways for several months after heavy rains. Low areas are also ponded when they receive water from adjoining areas.

The soils of this group and their plants provide a favorable habitat for deer, doves, quail, and other wildlife. Except when they come in to graze, the deer are few because these soils are covered by thin stands of mesquite, Vine-mesquite and filly panicum grow well and provide food for quail. Many kinds of ducks winter around the shallow intermittent lakes and around ponds built for watering livestock. Also wintering in the county are many sandhill cranes. These cranes, as well as the ducks feed on small grain and grain sorghum in irrigated fields. In winter deer frequent the edges of fields and feed on the small grain. Fishing for bass, bream, and channel catfish is good in the streams and other permanent water. The soils in this group can be managed so that the wildlife is increased.

WILDLIFE SUITABILITY GROUP 5

This wildlife group is in all the associations in the county except the Gila-Glendale, which is along the Rio Grande. The group consists of loamy Frio and Pintas soils and gravelly Dev soils, all of which are along streams that overflow at varying intervals. Internal drainage is medium to rapid, and surface runoff is slow. The Dev soils contain large amounts of limestone pebbles and stones. In some places the Pintas soil is subirrigated by water from perennial springs.

Many kinds of wildlife find an excellent habitat on the soils of this group because there is a wide variety of grasses, of forbs, and of browse plants. Bobwhite quail and scaled (blue) quail are abundant. The large live oaks, and the mulberry, mesquite, elm, pecan, and hackberry trees, provide roosting places for turkeys and nesting places for doves. On the Frio soils, deer, turkeys, javelina, and other wildlife feed on and are protected by the native plants. Where pecan trees grow on the Frio and Pintas soils, fox squirrels are abundant. Ducks and fish are plentiful, for there are many perennial streams and springs. Other wildlife obtain drinking water from streams and springs.

WILDLIFE SUITABILITY GROUP 6

This wildlife group is part of the Tarrant-Ector association, though it consists only of Ector soils mapped in complex with rock outcrop. These very shallow soils formed on limestone on the Rio Grande Plain. They are only in rolling to hilly areas in the Anacacho Mountains in the southeastern part of the county. Internal drainage is medium, and runoff is rapid.

These soils provide a habitat favored by whitetail deer. Food and cover for the deer are supplied by mid grasses, dense stands of low woody plants, and many other kinds of plants that grow throughout the year. The more important food-producing plants are blackbrush, acacia, guajillo, Texas colubrina, kidneywood, green sprangletop, slim tridens, bluestems, and bush sunflower. Because the soils in this group are very shallow and are hilly, they are periodically droughty and have little water available for wildlife, except at facilities provided for watering livestock. This lack of water, and the lack of large trees suitable for roosting, probably accounts for the small number of turkeys.

WILDLIFE SUITABILITY GROUP 7

This wildlife group corresponds to the Gila-Glendale association, in which there is a considerable acreage of Alluvial land, as well as the Gila and Glendale soils. These soils are loams or clay loams that formed in alluvium along the Rio Grande. They are seldom, if ever, flooded, but Alluvial land is frequently flooded. It is also subirrigated in many places where the water table is high. Internal drainage is medium to rapid, and runoff is slow.

Because much of the acreage of these soils is covered by dense stands of giantreed, a wide variety of plants does not grow. Consequently, supporting large numbers of deer is difficult, but deer from adjoining regions come into the area. Quail

are found in fields where giantreed has been mechanically shredded. The few trees on this wildlife group are mainly retama and willow. Many doves nest in the willows and feed on the seeds of grasses and weeds in adjoining wildlife groups. In this group some areas planted to grain sorghums or to blue panicgrass and similar grasses provide excellent food for doves, quail, and other birds.

Beavers live along the old river channels that have been cut off from the main stream of the Rio Grande. They are also along the perennial streams that flow into the river. Ducks spend the winter along the river and the cutoff channels. Small numbers of other shore birds stop over for short periods on their migrations southward and northward. In the streams are flathead catfish, channel catfish, bass, Rio Grande perch, and other fish.

Engineering Uses of Soils

By Robert F. Pearson, area engineer, Soil Conservation Service, Uvalde, Texas. Some information in this section is based on the experience of members of the Texas State Highway Department.

The information in this report can be used by engineers to:

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in the planning of agricultural drainage systems, farm ponds, irrigation systems, diversions, terraces, and other conservation structures.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables and in planning detailed investigations at the selected locations.
4. Locate probably sources of topsoil, sand, gravel, caliche, rock, and other material for use in construction.
5. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
6. Correlate the performance of engineering structures with soil mapping units and thus develop information for planning that will be useful in designing and maintaining the structures.
7. Obtain supplemental information from other published maps, reports, or aerial photographs for preparing reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to a particular area.

With the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works that involve heavy loads or where excavations are deeper than the depths of layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Much of the information in this subsection is in tables 3, 4, and 5. Table 3 lists estimates of engineering properties of the soils. In table 4 are engineering data obtained when selected soils in the county were tested. In table 5 are interpretations of engineering properties of the soils.

Some of the terms used by soil scientists may not be familiar to engineers. Other terms, though familiar, may have a special meaning in soil science. Most of the terms that are used here are defined in the Glossary at the back of this report.

Engineering classification systems

Two systems of classifying soils are in general use by engineers. Both of these systems are used in this report.

Many engineers use the system of soil classification developed by the American Association of State Highway Officials (AASHO) (*1*). In this system, soils are placed in seven main groups, or classes, on the basis of field performance. The groups range from A-1 (gravelly soils having high bearing capacity) to A-7 (clayey soils having low strength when wet). Of these groups, only A-1. A-2, A-4, A-6, and A-7 occur in Kinney County. Soils in group A-1 consist of well-graded, mainly coarse materials with nonplastic or only slightly plastic fines. Soils in group A-2 are mostly fine sand. Group A-4 consists of soils that are mainly silt and have only a small amount of coarse material and of sticky colloidal clay. Soils in group A-6 are clays of medium plasticity, and soils in group A-7 are highly plastic clays. Within each group the relative engineering value of the soil material is indicated by a group index number. Group index numbers range from 0 for the best material to 20 for the poorest. They are shown in parentheses after the engineering classification symbols in table 4.

The Unified system of soil classification was established by the Corps of Engineers, U.S. Army (*9*). This system is based on the texture and plasticity of soils and the performance of the soils as material for engineering works. Of the 15 classes in this system, 8 are for coarse grained material, 6 for fine-grained material, and 1 for highly organic material. Each class is identified by a letter symbol. The only classes represented in Kinney County are CL, CH, GC, ML, SC, SM, and the borderline class SP-GP. Soils in class CL are silts and clays that have a low liquid limit. CH identifies inorganic clays that are highly plastic. Class GC identifies clayey gravel and gravel, sand, and clay mixtures. Soils in class ML are inorganic silts and very fine sands, rock flour, silty or clayey fine sands, and clayey silts of slight plasticity. Soils in class SC are sands mixed with an appreciable amount of fines, mostly clay. Class SM consists of sands mixed with an appreciable amount of fines, mostly silt. The class SP-GP is near the borderline between classes SP and GP. Soils in class SP consist of poorly graded sands and gravelly sands and little or no fines. Soils in class GP consist of poorly graded gravel and gravel-sand mixtures with little or no fines.

Engineering properties of the soils

Listed in table 3, for each soil in Kinney County, are estimates of properties significant to engineering. The Unified and AASHO classifications were estimated on the basis of analyses of a large number of soil samples that were taken for the purpose of testing soils used in road construction and other purposes. These samples include the samples listed in table 4.

Permeability, as shown in table 3, was estimated for the soil material as it occurs without compaction or manipulation.

The available water capacity is given in inches of water per inch of soil. It is an estimate of the water available to plants when the soil is wet to field capacity. This amount of water will wet an air-dry soil to a depth of 1 inch without percolating deeper.

The shrink-swell potential indicates the change in volume that occurs in a soil when the moisture content changes. The estimates in table 3 are based on the kind and amount of clay in the soil. Clayey soils classified as CH or A-7 generally have a high shrink-swell potential. Sands and gravels that have a small amount of slightly plastic fines have a low shrink-swell potential.

Engineering test data

Engineering test data for three soil series are given in table 4. Samples were taken, by horizons, from nine soil profiles in Kinney County and were tested by the Texas Highway Department according to standard procedures of the American Association of State Highway Officials (*1*). Three profiles of each soil were sampled. The first is a modal profile, or a profile most typical of that soil as it occurs in Kinney County. The second and third are nonmodal profiles, or profiles that vary from the modal but are in the range allowed for that series.

The engineering soil classifications in table 4 are based on data obtained by mechanical analyses and by tests to determine the liquid limit and the plastic limit. The *plastic limit* is the moisture content at which the soil material passes from a semisolid to a plastic state. The *liquid limit* is the moisture content at which the material passes to a liquid state. The *plasticity index* is the numerical difference between the plastic limit and the liquid limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

As moisture is removed from a soil, the volume of the soil decreases, in direct proportion to the loss of moisture, until a condition of equilibrium, called the *shrinkage limit,* is reached. Beyond the shrinkage limit, more moisture may be removed, but the volume of soil does not change. In general, the lower the shrinkage limit, the higher the content of clay. *Lineal shrinkage* is the decrease in one dimension of the soil mass that occurs when the moisture content is reduced from a stipulated percentage to the content at shrinkage limit. Lineal shrinkage is expressed as a percentage of the original dimension.

The *shrinkage ratio is* the volume change resulting from the drying of soil material, divided by the loss of moisture caused by drying. The ratio is expressed numerically.

Engineering interpretations

In table 5 the soils are evaluated for engineering uses. Specific features of the soil that may affect engineering work are listed. These features were estimated on the basis of actual test data and on observations of field performance.

The ratings of the soils for road subgrade are based on the soil material as it exists from the surface to limestone or bedrock. Montell clay and other plastic clays are rated *poor* because they have slow internal drainage and low stability when wet. Soils, such as Kavett-Tarrant stony clays, are rated *poor* because they are very shallow over hard limestone. If the limestone is quarried and crushed, however, it makes excellent subgrade and road fill material. Quemado soils are rated *good,* for they consist of much coarser textured, better graded materials than those of Kavett-Tarrant stony clays.

The suitability for road fill depends largely on the texture of the soils and the normal content of water. Plastic soils, such as Montell clay, normally have a high content of water and are rated *poor* because they are difficult to handle, to compact, and to dry to the desired content of water. The Kimbrough soils consist of well-graded materials that have low shrink-swell potential and are rated *good* for road fill. Kimbrough soils are also an excellent source of caliche.

Pintas silty clay loam, a deep, dark-colored soil, is a *good* source of topsoil. Gravelly and stony soils are *poor* sources of topsoil. Alluvial land, along the Rio Grande, is a source of poorly graded sand. In places Dev soils, along streams in the northern part of the county, are a source of sand and gravel, but the material requires washing and grading.

If new homes in rural areas are constructed, or old ones modernized, sanitary disposal of sewage is required. A column in table 5 rates the soils according to their limitations for the disposal of sewage effluent. Tests at the proposed site are required

for determining the suitability of soils that have moderate or severe limitations to the disposal of sewage effluent. Some soils so rated may have only slight limitations if large disposal fields are used. Soils that overlie fractured limestone have severe limitation to disposal of effluent because the effluent may pollute water downstream that is used for drinking.

Road construction in the northern one-third of the county is difficult because the terrain is rough and hard limestone is at or near the surface. For vertical alignment of highways, blasting is required in many places, and then special equipment is needed for handling the blasted material.

In table 5 features that affect farm ponds are given for the reservoir area and the embankment. On the nearly level clayey soils along creeks, both dug ponds and ponds with embankments are constructed. Little or no special treatment for sealing the soil material is required. If embankments are constructed for impounding water on permeable soils, special placement and compaction of the earth materials are required. Also, the reservoir area may require special treatment before sealing. Constructing ponds on soils that have a sandy or gravelly substratum is not advisable. Some soils, such as the Ector and Tarrant, do not have enough soil material for constructing a dam, but small rubble masonry or concrete dams are excellent for impounding water where the creeks have limestone bottoms.

Irrigation is not extensive in Kinney County, though the acreage in irrigated cropland is increasing. Surface flow is used in most irrigation systems in the county. In table 5, however, a column headed "Sprinkler system" is included because it is practical to seed tame pasture on some of the steeper, permeable soils and to irrigate them by sprinklers.

Only a few field terraces are needed in Kinney County, and they should be level and constructed on deep soils. Diversion terraces are constructed to protect cultivated fields and to divert water into or away from farm ponds. Waterways are used for conducting water from other areas through natural depressions across cultivated fields.

Winter grading and frost action are not considered problems, because the soils generally have a low content of moisture during the winter, and subfreezing temperatures that last more than a day are rare.

Formation, Classification, and Morphology of Soils

The purpose of this section is to present the outstanding morphologic characteristics of the soils of Kinney County and to relate them to the factors of soil formation. The section consists of four main subsections. The first subsection tells how the soils of Kinney County were formed. In the second subsection the soil series are placed in higher categories of the two systems of soil classification currently used. In the third subsection the morphology of the soils is discussed, and the profile of a soil representative of each soil series is described. The fourth subsection discusses the geomorphology and geology of the soils in the county.

Factors of Soil Formation

Soil is produced when soil-forming processes act on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated, (3) the living organisms, or plant and animal life, in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the soil-forming forces have acted on the soil material.

Climate and living organisms (chiefly vegetation) are the active factors of soil formation. They act on the parent material and slowly change it from an inert mass to a body having definite morphology. The effects of climate and living organisms are

conditioned by relief. The parent material also affects the kind of soil profile that forms. Finally, time is needed for the changing of the parent material into a soil having definite genetically related horizons.

The interrelationships among the five factors of soil formation are complex. Although the effects of any one factor are difficult to isolate, it is convenient to discuss each factor of soil formation separately and to indicate some of their probable effects. One should keep in mind that the factors interact continually in the processes of soil formation and that the interactions determine the kind of soil that forms.

Parent material

In Kinney County the formation of some soils has kept pace with the weathering of parent rock, as indicated by the small amount or absence of parent material between the solum and the parent rock. Other soils in the county have thick beds of parent material between the parent rock and the solum, but distinct horizons have not formed in this material.

In Kinney County the soils have developed from four kinds of parent material: (1) that formed in place through disintegration and decomposition of hard limestone and basalt; (2) that formed in place from soft chalky limestone, marl, or caliche; (3) that was transported from its place of origin and redeposited before it became subject to important changes by soil-building forces; and (4) that was first modified by the soil forming processes and then transported from its place of origin and redeposited.

Parent material that formed in place through the weathering of hard limestone gives rise to Tarrant soils, Kavett stony clay, and Ector soils (stony), and parent material from weathered basalt gives rise to Ingram stony clay. In the formation of all these soils, the parent material is used up about as fast as it forms, and there is little or none left between the solum and the parent rock. Limestone and basalt weather slowly.

Parent material that formed from soft, chalky limestone, marl, or caliche gives rise to Ector soils (gravelly), Kimbrough soils, Quemado soils, and Zapata soils. These parent rocks weather a little faster than hard limestone. Some of the calcium carbonate in the soil goes into solution. It is then carried downward a few inches, is redeposited, and forms an enriched layer of calcium carbonate beneath the solum.

Developed from parent material that has been transported from its place of origin and redeposited before it was greatly modified are Knippa silty clay, Montell clay, Reagan loam, and Uvalde silty clay loam. The parent material of these soils originated from limestone rocks and, as sediment, was transported by water and redeposited at its present location during the Pleistocene epoch (Ice Age). Deep soils formed from these unconsolidated sediments. These soils have an accumulation of calcium carbonate about 3 feet below the surface.

Pintas silty clay loam, Frio clay loam, Gila loam, and Glendale clay loam developed from parent material that was first modified by the soil-forming processes and then transported from its place of origin and redeposited. These soils formed in alluvium that was laid down along rivers and creeks. With each flood, sediment is added in some places and is removed in others. The Gila and Glendale soils formed in sediment that weathered from rocks of mixed origin and that has been carried far downstream by the Rio Grande. The parent material of the Pintas and Frio soils was mainly weathered from limestone. All of these soils are deep, friable, and immature, and except for a surface layer darkened by organic matter, they have indistinct horizons.

Additional information about the parent material is given in the subsection "Geomorphology and Geology."

Climate

Precipitation, temperature, humidity, evaporation, and wind have all been important in the development of soils in Kinney County. The wet climate of past geologic. ages influenced the deposition of parent materials.

The present semiarid climate, characterized by low rainfall, hot. summers, and mild winters, has a striking effect on soil development. Indications of this effect are the kind and density of vegetation, the organic-matter content of the soils, the leaching of soluble elements from the soil, and the activity of micro-organisms in the soil.

Low rainfall limits the vegetation to grasses, shrubs, and small trees, except in some areas along the perennial streams. This vegetation accounts for the organic-matter content of the soils. Free lime occurs throughout the profile of some soils because not enough water passes through them to leach out the lime. Most of the soils in Kinney County have a layer of calcium carbonate at the depth to which water has carried this soluble material.

Almost all of the precipitation in the county falls as rain. Some rain falls in torrents and, especially as runoff from steep slopes having sparse cover, removes soil material almost as fast as it forms. In places where torrents are infrequent, one hard rain can remove in a few minutes what it has taken nature years to build.

A rainfall of one-half inch may be enough to soak a very shallow, stony soil. Water runs off the stones, penetrates the soil, and finds its way under stones and in crevices where plant roots can use it. Much of the water also percolates below the zone of evaporation. On the other hand, 1/2 inch of rain may wet only the upper 2 inches of a clay soil. This moisture may evaporate soon after the rain. One-half inch of rainfall on the stony soil may be equivalent to more than 1 inch on the clayey soil having no stones. The stony soils support tall grasses, in contrast to the short grasses on the clayey soils having no stones or only a few.

During the hot summers and mild winters, microbial decomposition is almost continuous, and the residues from plants and animals break down almost as fast as they accumulate. For this reason, the organic-matter content of most soils in the county remains about 1 or 2 percent.

Living organisms

Plants, animals, insects, bacteria, fungi, and the like are important to soil formation. Native vegetation of the mixed prairie type has contributed large amounts of organic matter to the soil. The organic matter is on the soil in the form of decaying leaves and stems. It is throughout the solum in the form of fine, fibrous, decomposed roots that have left a network of tubes and pores that hasten the passage of air and water through the soil and provide abundant food for bacteria, actinomycetes, and fungi.

Plant roots may take up calcium, potassium, phosphorus, or other nutrients in lower layers of soil and then redeposit these elements on the soil surface when the plants die. Burrowing animals also mix soil horizons as they build homes or gather food.

Earthworms are noticeable in the soil. Despite the low rainfall in this county, and the periods when the entire solum is dry, some horizons in the Frio, Uvalde, and other soils are 20 to 40 percent worm casts. Besides mixing the soil, earthworms increase the movement of air, water, and plant roots in a soil.

The influence of man on soil formation should not be ignored. Man has permitted the range to be severely overgrazed. This overgrazing has removed many kinds of grasses from the range and has encouraged other, less nutritious grasses to take their place. Much of the range now has sparse vegetation, which allows large amounts of rainfall to run off and carry soil with it. In addition, the sparse vegetation

permits the soil temperature to rise in summer, and the heat kills many of the microbes in the soil. These are only a few of the changes caused by man's activity, but all of his changes affect soil formation.

Relief

Relief, or the lay of the land, has greatly influenced soil formation in Kinney County, mainly through its effect on runoff and drainage.

Most of the county is well dissected by drainage patterns. The Edwards Plateau, which makes up the northern one-third of the county, is a rough region that is cut into mesas, ridges, hills, valleys, and canyons. Within short distances, elevations range from 200 to 400 feet. Runoff from rainfall is very rapid, and geologic erosion removes the soil almost as fast as it develops. In about 40 percent of this area, slopes are steeper than 20 percent and prevent a soil profile from forming. These rugged areas were mapped as Limestone rockland. On the rest of the Edwards Plateau, which is slightly less sloping, soils that are very shallow over limestone generally developed. Examples are Tarrant and Ector soils. Kavett stony clay formed on narrow, gentle slopes in a few protected valleys and is shallow over limestone.

The relief of the Anacacho Mountains in the southeastern part of the county is similar to that of the Edwards Plateau, and some of the soils and rocks are also similar. Examples are Ector-Rock outcrop complex and, on the steeper slopes, Limestone rockland.

The southern two-thirds of the county (Rio Grande Plain) ranges from a nearly level plain to gently sloping hills and has well-defined drainage patterns in all parts except the south-central. The south-central part is nearly level, flat, and featureless; its drainageways are poorly defined. Here, the soil is deep, firm Montell clay, which has a high potential for shrinking and swelling on wetting and drying. Almost all of the rainfall enters the soil, and erosion is not a problem. Drainage is not a problem because the climate is semiarid.

Most of the Rio Grande Plain consists of gently rolling hills or ridges and nearly level valleys or flood plains. The soils on the hills are very shallow over caliche. From slopes of 1 to 8 percent, runoff is excessive after heavy rains and soil material is removed from these slopes about as fast as it is developed. On these slopes are the Kimbrough and Ector soils. Deep soils of the Uvalde, Reagan, and Knippa series are in shallow, broad, nearly level valleys. These soils are well drained, and erosion is not a problem. Erosion also is not a problem on the deep, friable, nearly level Pintas or Frio soils on flood plains along spring-fed streams.

Near the Rio Grande is an ancient, high terrace, which is gently undulating but is deeply dissected at the margin nearest the river. Here the soils are very shallow over caliche and over gravel of mixed origin. Quemado soils are on the smoother parts of the terrace; Jimenez and Zapata soils are on the deeply cut slopes, where erosion removes soil material about as fast as It forms. Erosion is not a problem along the smooth flood plain of the Rio Grande where the deep, friable Gila and Glendale soils formed.

The igneous hills, such as Las Moras Mountain, have steep slopes, shallow, stony soils, and a few small talus deposits of basalt. Ingram stony clay is the soil on these igneous hills.

Relief affects the microclimate and ecology in places. The steeper, north-facing slopes receive less sunlight than south-facing slopes and have lower soil temperature and less evaporation. The vegetation is thicker on most north-facing slopes, and soil organisms are more numerous. Even the kinds of plants and micro-organisms are different on north-facing slopes, compared to those on south-facing slopes. The north-facing slopes are not green so early in spring as are south-facing slopes, which receive more direct sunlight.

Because of the differences in soil temperature, effectiveness of moisture, vegetation, and micro-organisms, the soils on north-facing slopes may eventually become deeper and darker colored than the soils on steep, south-facing slopes and higher in organic-matter content.

Additional information on relief is given in the subsection "Geomorphology and Geology."

Time

Time is required for soil formation, and many characteristics of a soil are determined by the length of time that the soil-forming processes have acted on the soil material.

An extremely long time is needed for a soil to develop from freshly exposed, fairly pure limestone. The limestone dissolves slowly while the rains come and go. As the mass of limestone dissolves slowly and is carried away, any impurities present are left to form parent material. Under such conditions, many thousands of years may pass before parent materials have accumulated and horizons can form.

A soil having distinct horizons may form in fresh alluvium within a few decades or centuries. Frio soils formed in material similar to that of the Uvalde soils. Uvalde soils have a distinct horizon, where calcium carbonate that leached from upper horizons has accumulated. This layer of calcium carbonate does not occur in Frio soils, because they are much younger than Uvalde soils. Frio soils are old enough to have a surface laver that has been darkened mainly by the addition of organic matter. Living organisms have acted on the parent material of Frio soils long enough to give them a distinct surface layer, but climate, particularly rainfall, has not acted on Frio soils long enough to give them distinct layers of calcium carbonate, such as those in the Uvalde soils.

In this area soils develop in a dry climate under sparse vegetation from materials that generally contain much lime. Because the action of the dry climate and sparse vegetation is slow, a long time is required before a soil reaches maturity. Also, leaching of carbonates and salts from the upper part of the profile seems to be a necessary prelude to the downward movement of silicate clays that is needed before genetically related A and B horizons develop. Time has not been sufficient for the carbonates to leach downward in the limy soils of Kinney County, and for genetic A and B horizons to form.

Classification of the Soils

Soils are classified so that we may more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationships to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First, through classification and then through use of soil maps, we can apply our knowledge of soils to specific tracts and other parcels of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, ranches, and woodland; in developing rural areas; in engineering work; and in many other ways. Likewise, soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of natural classification of soils are now in general use in the United States. One of these is the 1938 system (*2*), with later revisions (*8*). The other, a current system, was placed in general use by the Soil Conservation Service In 1965. The reader who is interested in the current system should search the literature (*5,7*). Modifications in the system are made as knowledge of soils increases. In this report classes in the current system, and great soil groups of the older system, are given in

table 6. The classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions are the Entisols and Histosols, which occur in many different climates.

Table 6 shows the four soil orders in Kinney County—Entisols, Vertisols, Aridisols, and Mollisols. Entisols are recent soils that do not have genetic horizons or have only the beginnings of such horizons. The soils of this order in Kinney County formerly were called Alluvial soils and Lithosols.

Vertisols are soils in which natural churning or inversion of soil material takes place, mainly through swelling and shrinking of clays. Soils of this order in Kinney County were formerly called Grumusols.

Aridisols are soils that are light colored and are dry much of the time. In Kinney County the soils of this order were formerly called Calcisols and Lithosols.

Mollisols have a thick, dark surface layer of which more than 1 percent is organic matter. These soils also have good structure and do not shrink and swell as do the Vertisols. Mollisols have more than 50 percent base saturation; calcium is the dominant metallic cation. In Kinney County the soils of this order were formerly classified in the Chestnut, Calcisol, Lithosol, and Alluvial great soil groups.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes having the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUPS: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated. The features used are the self-mulching properties of clays, soil temperature, and major differences in composition of chemicals, mainly that of calcium, magnesium, sodium, potassium, and the like. The name of the great group is the last word of the name of the subgroup. The great group is not shown in table 6 for the current classification system.

SUBGROUPS: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group and others, called intergrades, that have properties of one great group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Mollie Calciorthids (a dry soil having a darker surface layer than normal and a horizon enriched with calcium).

FAMILIES: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. An example of a family is the fine silty, mixed, thermic family of Mollie Calciorthids.

SERIES: The series is a group of soils having major horizons that, except for texture of surface layer, are similar in important characteristics and in arrangement in the profile. The soil series generally is given the name of the geographic location near the place where a soil of that series was first observed and mapped. An example is the Uvalde series.

Morphology of Soils

The relationship of the outstanding morphological characteristics of the soils of this county to the factors of soil formation is briefly discussed in this subsection.

Soil morphology is expressed in many ways in the soils of Kinney County. Some soils have distinct horizons; others have only faint horizons. The differentiation of horizons in soils is a result of several factors. Among these are (1) the accumulation of organic matter, (2) the leaching of carbonates and salts, (3) the translocation of silicate clay minerals, and (4) the reduction and transfer of iron. In most soils in the county, two or more of these processes have been active in the development of horizons. For example, the influence of the first two factors is reflected in the horizons of Uvalde silty clay loam. The influence of the first factor is dominant in the morphology of Frio clay loam.

In the uppermost layer of all the soils in Kinney County, some organic matter has accumulated and an A horizon has formed. Most of this organic matter is in the form of humus. The organic matter ranges from about 1/2 percent of the horizon in some soils to about 4 percent in others.

Some carbonates and salts have been leached from most of the soils in the county, though this leaching has been limited in some soils. In only the Quemado soils has leaching been sufficient to permit the subsequent translocation of silicate clay minerals.

Iron has been reduced and transferred only in the Montell soils.

A prominent horizon of accumulated calcium carbonate, called caliche, is a significant characteristic of most of the soils in Kinney County. This layer is usually called a Cca horizon in the Uvalde soils, or a Ccam horizon as in the Kimbrough soils.

The layers of calcium carbonate in the soils of this county have formed in one or two ways, or in a combination of the two. The first is the leaching of carbonate from the upper horizons. The depth to which these carbonates move in the soil is related to the amount of moisture that enters the soil. In more humid regions the carbonates are leached out of the soil in some places. Since rainfall is low in Kinney County, the amount of water that percolates through the soil is not sufficient to remove the calcium carbonate added by parent material. The carbonate generally accumulates at about the depth to which surface water ordinarily percolates. The Uvalde soils have a Cca horizon that was formed in this manner.

The second way that the carbonate layers formed is by precipitation of calcium from high water table. The ground water is saturated with carbonates, and as it evaporates, these carbonates are deposited in the soil. The Cca horizon of the Pintas soils was formed in this manner.

Some soils do not have horizons of calcium carbonate, either because of their age or because of the nature of their parent materials. The Frio, Gila, and other soils on bottom lands are so youthful that carbonates have not moved downward to a great extent.

Descriptions of the Soil Series

Each series represented in Kinney County is described in the following pages. First described are important characteristics that apply to the soils in the series, as these soils occur in the county, and then a profile representative of the series is described. This profile was observed at a specified location. Also mentioned is the degree to which horizons in the soils of a series may differ from horizons in the profile described as typical, or modal, for that series.

DEV SERIES

The Dev series consists of very gravelly calcareous soils that formed on limestone along streams having a high gradient. These soils are frequently flooded because they are only a few feet above the stream channel. Floodwaters scour these soils and deposit sediment. The vegetation is a sparse cover of brush and grass.

Dev soils occur with the Frio soils, which are clay loams and are not gravelly.

Representative profile (100 feet south of Tularosa Road, at a point 12.7 miles north of intersection with Farm Road 334; the intersection is 12 miles northeast of Brackettville):

A1—0 to 14 inches, dark grayish-brown (10YR 4/2) gravelly clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; 50 percent of the soil mass, by volume, is rounded limestone pebbles, mostly less than 6 centimeters in diameter; few cobbles and stones; calcareous; pH 8.0; gradual, wavy boundary.

C—14 to 90 inches +, pale-brown (10YR 6/3) very gravelly clay loam, brown (10YR 4/3) when moist; weak granular structure; about 70 to 90 percent, by volume, is rounded limestone pebbles; few cobbles and stones; few, thin, erratic strata of more clayey material; calcareous.

The A1 horizon ranges from 10 to 25 inches in thickness. This horizon, when dry, ranges from dark grayish brown to light brownish gray; it has a hue of 10YR, value of 4 through 6, and chroma of 2. The texture of the fine material ranges from loam to clay loam or silty clay loam. Coarse fragments make up from 50 to 90 percent of the horizon, by volume.

The C horizon, when dry, ranges from light brown to very pale brown. The upper part of the C horizon has the same range in texture of the fine material as the A1 horizon and the same range in volume of coarse fragments. Thin strata having other textures, or other proportions of coarse fragments, generally occur in the lower part of the C horizon. Depth to limestone bedrock is normally more than 6 feet.

ECTOR SERIES

The Ector series consists of grayish-brown, calcareous, gravelly or stony soils that are very shallow over hard limestone. These soils formed in undulating to hilly areas under vegetation consisting of short and mid grasses and thorny brush. In the present vegetation are thin stands of red grama, guajillo, leatherstem, and blackbrush.

The Ector soils are gravelly loams and stony loams. The gravelly loams occur closely with the Kimbrough soils (gravelly loams), which overlie thick beds of caliche instead of limestone. The stony loams are closely associated with the Tarrant soils (stony clays) but are lighter in color and less stony. Ector soils are grayer and more alkaline than Quemado soils, which overlie thick beds of caliche.

Representative profile on a gently undulating slope of about 2 to 5 percent (in northwestern part of the county, 0.1 mile east of Val Verde County line on Farm Road 2523):

A1—0 to 8 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 3.5/2) when moist; weak granular structure; soft when dry, friable when moist; about 30 percent of the soil mass, by volume, is angular pebbles and cobbles of limestone; calcareous; abrupt boundary.

R&A—8 to 12 inches, 5 parts of angular cobbles of limestone and 2 parts of grayish-brown (10YR 5/2) loam; caliche coating is very thin on upper side of cobbles but is as much as one-fourth inch thick on underside; cobbles are in a discontinuous platy layer; abrupt boundary.

R—12 to 18 inches, white, very hard limestone; fractures and crevices filled or partly cemented with hard caliche.

The A1 horizon ranges from 3 to 12 inches in thickness. This horizon, when dry, is grayish brown, brown, or dark grayish brown of a 10YR hue. Value is more than 3 when the A1 horizon is wet. Texture ranges from loam to light clay loam or silt loam. Limestone fragments cover from 35 to 80 percent of the surface. In the A1 horizon, limestone fragments make up 20 to 70 percent of the volume and are mostly the size of pebbles and cobbles.

The underlying limestone is many feet thick and is fractured or massive. In most places caliche coats the upper rocks and fills the cracks and crevices in the limestone. Over the limestone in some places, there is a relict Ccam horizon of indurated caliche 1 or 2 inches thick. This layer is broken into plates, less than 10 inches across, and has fine material between and under the plates.

FRIO SERIES

The Frio series consists of deep, friable soils that are dark colored and calcareous. These soils formed in narrow bands on smooth, nearly level to gently sloping flood plains along streams in all parts of the county. The parent material consists of silty and loamy sediments that washed from soils formed on limestone. These soils formed under a cover of tall and mid grasses and an overstory of large live oaks and pecan trees.

Frio soils are closely associated with Pintas, Glendale, and Uvalde soils, but the thick layer of calcium carbonate that occurs in the Pintas and Uvalde soils is missing in the Frio soils. Also missing is a fluctuating high water table like the one in the Pintas soils. The Frio soils are darker colored than the Glendale soils, which formed in mixed sediments.

Representative profile (about 20 miles northeast of Brackettville on Tularosa Road, on the north side of the West Nueces River, 0.2 mile east of the gate):

A1—0 to 22 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2.5/2) when moist; weak to moderate, fine and very fine, granular structure; hard when dry, friable when moist; many worm casts; many fine and very fine pores; few snail shells; calcareous; pH 8.0; gradual boundary.

B2—22 to 38 inches, brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; weak to moderate. fine and very fine, granular structure; hard when dry, friable when moist; common worm casts; many fine and very fine pores; few snail shells; calcareous; pH 8.0; gradual boundary.

C—38 to 70 inches H , brown (10YR 5/3) silty clay loam. dark brown (10YR 4/3) when moist; weak granular structure; hard when dry, friable when moist; calcareous; pH 8.2.

The A1 horizon ranges from 12 to 25 inches in thickness. This horizon is generally grayish brown to very dark grayish brown, but in a few places it is brown or dark brown. Structure is granular or subangular blocky.

The B2 horizon ranges from 10 to 20 inches in thickness. In most places this horizon ranges from grayish brown to brown, but in a few places it is pale brown.

Structure and texture are about the same as they are in the A1 horizon.

The C horizon generally is at a depth of several feet, and in many places it becomes fairly gravelly and stratified as depth increases. The color ranges from light brownish gray to brown. In a few places there is a thick Cca horizon that appears to have formed from calcium carbonate deposited by ground water.

The amount of gravel ranges from none to about 15 percent in the surface layer and from none to more than 50 percent in the lower horizons.

GILA SERIES

The Gila series consists of deep, friable soils that are light brownish gray and strongly calcareous. These soils formed on a smooth, nearly level second bench along the Rio Grande. They are about 20 to 30 feet higher than the river channel, where they extend in a nearly continuous strip about 1/4 mile wide and nearly 15 miles long. Gila soils are seldom flooded. The parent material consists of sandy and silty sediments that weathered from many kinds of rocks in arid and semiarid regions. These soils formed under a cover of mid and short grasses and scattered thorny brush.

Gila soils are lighter in color and more sandy than the closely associated Glendale soils.

Representative profile (about 0.2 mile south of the head of the Maverick County Canal and 0.3 mile north of the Rio Grande, in a recently root-plowed field):

A1—0 to 20 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak granular structure; slightly hard when dry, very friable when moist; few fine pores and common very fine pores; few worm casts; few fine fragments of quartz, limestone, and snail shells; many very fine flakes of mica; calcareous; pH 8.2; diffuse boundary.

C—20 to 60 inches +, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; structure, consistence. reaction, and other characteristics same as in A1 horizon.

The A1 horizon ranges from 12 to 30 inches in thickness. This horizon, when dry, generally varies only slightly from light brownish gray (10YR 6/2); hue is 10YR, value is 5 or 6, and chroma is 2 or 3.

The C horizon ranges from pale brown to very pale brown in a hue of 10YR. Texture is generally loam, but it ranges to light silt loam or very fine sandy loam. In some places this horizon is finely stratified with sand and silt, especially below a depth of 36 inches.

GLENDALE SERIES

The Glendale series consists of deep, friable soils that are grayish brown and strongly calcareous. These soils formed on a smooth, nearly level old flood plain, or low terrace, along the Rio Grande. They are about 30 to 40 feet higher than the river channel and are seldom flooded. These soils are in a strip less than 400 yards wide and 1 miles long. The parent material consists of silty and loamy sediments weathered from many kinds of rocks in arid and semiarid regions. These soils formed under mid and short grasses and scattered thorny brush.

Glendale soils occur closely with the Gila soils but are darker colored and less sandy.

Representative profile where slope is less than 0.2 percent (about 1,000 feet south and 600 feet west of the red gate on Old Military Road, about 21/2 miles north of the Maverick County line):

Ap—0 to 5 inches, grayish-brown (10YR 5.5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; structure is weak platy in upper 1 inch and weak granular below; hard when dry, friable when moist; few worm cast; few insect cavities; few snail shells; common very fine flakes of mica; calcareous; pH 8.0; abrupt boundary.

A1—5 to 24 inches, grayish-brown (10YR 5/1.5) clay loam, very dark grayish brown (10YR 4/2) when moist; moderate, fine and very fine, granular structure; hard when dry, friable when moist; many worm casts; few insect cavities; few snail shells; few very fine pebbles; many fine and very

fine pores; few films and threads of calcium carbonate: common very fine flakes of mica; calcareous; pH 8.0; diffuse boundary.

C1—24 to 40 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak granular structure; bard when dry, friable when moist; many very fine pores; few worm casts; few threads and films of calcium carbonate; few snail shells; common very fine flakes of mica; calcareous; pH 8.0; diffuse boundary.

C2—40 to 62 inches +, pale-brown (10YR 6.5/3) light silty clay loam, brown (10YR 5/3) when moist; weak granular structure ; hard when dry, friable when moist; many very fine pores; few worm casts; few threads and films of calcium carbonate; few snail shells; many fine flakes of mica; calcareous; pH 8.0.

The Ap horizon ranges from 4 to 10 inches in thickness. Its color ranges from grayish brown to light brownish gray and has a hue of 10YR, a value of 5 or 6, and a chroma of 2. Structure is weak and ranges from granular to subangular blocky, except in the top inch, which is platy. The A1 horizon ranges from 12 to 20 inches in thickness. It has the same range in other characteristics as the Ap horizon. The Ap and A1 horizons combined average about 24 inches in thickness.

The C1 horizon is 8 to 20 inches thick and is brown or pale brown. The C2 horizon ranges from pale brown to very pale brown. It ranges from clay loam to heavy loam or silty clay loam.

Throughout the profile in many areas are fine fragments of quartz, limestone, sandstone, and snail shells. In places the C horizon is thinly stratified with sand, silt, and clay.

INGRAM SERIES

The Ingram series consists of shallow, dark-brown stony clays that formed on hills that rise as much as 500 feet above the surrounding plain and have slopes of 5 to more than 20 percent. These soils formed on volcanic sills, which are igneous intrusions. The sills and the Ingram soils are of minor extent in Kinney County. The vegetation consists mainly of a thick stand of fall witchgrass, sideoats grama, blackbrush, guajillo, and pricklypear.

Ingram soils formed in a different kind of parent material than did the rest of the soils in the county. They are associated with Kimbrough and Ector soils but are browner and more clayey.

Representative profile where slope is between 5 and 8 percent (6 miles east of Brackettville Courthouse and 1/4 mile south of U.S. Highway No. 90 on Palmer Hill):

A11—0 to 12 inches, dark-brown (7.5YR 3/2) stony clay, very dark brown (7.5YR 2/2) when moist: moderate, fine and very fine, subangular and blocky structure; very hard when dry, firm when moist; many grass roots, many worm casts; about 20 to 50 percent of the soil mass, by volume, is fragments of basalt, mostly less than 6 inches in size but ranging up to 15 inches; 60 percent of surface is covered with fragments of basalt, two-thirds of which are more than 6 inches across; noncalcareous; pH 7.5; gradual boundary.

A12—12 to 18 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) when moist; moderate, very line, subangular blocky structure; very hard when dry, firm when moist; about 90 percent of the soil mass is fragments of basalt; noncalcareous; pH 7.6; abrupt boundary.

Cca—18 to 20 inches, pink (7.5YR 8/4) caliche, pink (7.5YR 7/4) when moist; calcareous; pH 8.2; calcium carbonate in pockets; clear boundary.

R&C—20 to 36 inches +, stones and gravel and a small amount of clayey material in cracks; noncalcareous.

The A11 horizon ranges from 6 to 15 inches in thickness. This horizon ranges from dark brown to very dark grayish brown. Structure is moderate or strong and ranges from blocky to granular. Within a horizontal distance of a few feet, the proportion of stones on the surface and within the soil ranges from 15 to 70 percent.

The A12 horizon ranges from 4 to 10 inches in thickness. It ranges from reddish brown to brown in color and from fine granular to blocky in structure. This horizon is neutral to moderately alkaline and is calcareous in some places. The volume of stones and gravel ranges from 50 to 90 percent.

The Cca horizon is generally thin, but in places it is as much as 6 inches thick. In many places it is absent or is only a coating of calcium carbonate on the basalt rocks. In other places the. Cca horizon consists of distinct pockets of caliche containing more than 50 percent calcium carbonate.

Depth to the R&C horizon of basalt rubble ranges between 10 and 22 inches. This horizon is calcareous in spots. It grades gradually into hard igneous material that is fractured in the upper few feet.

JIMENEZ SERIES

The Jimenez series consists of dark-colored, calcareous very gravelly loams that are very shallow over thick beds of caliche. These soils formed on high terraces near the Rio Grande in old alluvium that is gravelly and of mixed origin. Jimenez soils are 100 to 200 feet higher than the river channel and are choppy, much dissected, strongly sloping, and hilly. They formed under a thin cover of grasses and thorny brush.

Jimenez soils are closely associated with the Zapata soils but are darker colored. They are more limy and grayer than Quemado soils and are more gravelly than Kimbrough soils.

Representative profile (about 20 miles southwest of Brackettville and 2 miles west of intersection of U.S. Highway No. 277 and Farm Road 396; or about 2 miles east of the Rio Grande):

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak granular structure; slightly hard when dry, friable when moist; about 70 to 80 percent of the soil mass, by volume, is waterworn pebbles of quartzite, chert, limestone, sandstone, and basalt; most pebbles are less than 3 inches in diameter; few cobbles; calcareous; abrupt boundary.

C1cam—8 to 18 inches, white (10YR 8/2) indurated caliche; about 40 percent of the mass is embedded gravel; diffuse, irregular boundary.

C2—18 to 60 inches +, white (10YR 8/2) slightly cemented or massive caliche; about 50 percent of the mass is gravel.

The A1 horizon ranges from 3 to 15 inches in thickness. It ranges from grayish brown to very dark grayish brown and has a hue of 10YR, value of 3 to 5, and chroma of 2 or 3. The texture of the A1 horizon ranges from loam to light clay loam or sandy loam. Pebbles cover the surface and are weathered smooth, but they lack the desert varnish that appears in more arid regions. The amount of gravel in the A1 horizon ranges from 50 to 80 percent of the soil mass.

The C1cam horizon ranges from 8 to 20 inches in thickness. Its upper surface is generally smooth but is finely etched, and its upper 1/4 to 1/2 inch is finely laminated. In many places the upper 2 to 3 inches is fractured into plates. The induration of the C1cam horizon ranges from moderate to strong. The C2 horizon ranges from 3 to 20 feet in thickness and is underlain by limestone or calcareous clay and shale.

KAVETT SERIES

The Kavett series consists of very dark grayish-brown, neutral to moderately alkaline stony clays that are shallow over limestone. These nearly level to gently sloping soils are in narrow valleys between areas of Tarrant soils on ridges and hills. Kavett soils formed under mid and short grasses, small trees, and brush. Live oaks and cedars are numerous, and there is a thick cover of curly mesquite.

Kavett soils are closely associated with the Tarrant soils but are deeper than those soils.

Representative profile where slope is less than 1 percent and boulders cover about 2 percent of the surface, stones 5 percent, cobbles 10 percent, and outcrops 2 percent (0.6 mile east of bump gate at Coates Ranch on Farm Road 674, about 20 miles north of Brackettville):

A11—0 to 9 inches, very dark grayish-brown (10YR 3/1.51 clay, very dark brown (10YR 2/2) when moist; moderate, medium to coarse, prismatic structure that breaks to medium and fine, subangular blocky; very bard when dry, firm when moist, sticky and plastic when wet; few very fine pores; many fine grass roots; mildly alkaline but is calcareous in spots; pH 7.8; clear boundary.

A12—9 to 15 inches, dark grayish-brown (10YR 3.5/2) clay, very dark brown (10YR 2/2) when moist; structure and consistence same as in A11 horizon; few very fine pores; many fine grass roots; about 20 percent of the soil mass, by volume, is fine concretions of calcium carbonate; calcareous; pH 8.0; abrupt boundary.

Ccam—15 to 18 inches, white (10YR 8/2) cemented caliche, very pale brown (10YR 7/3) when moist; fractured into slabs, 6 to 20 inches across, that are smooth and hard on top and knobby and softer beneath; calcareous; abrupt boundary.

R—18 to 24 inches +, white (10YR 8/1) fractured limestone, white (10YR 8/2) when moist; some soft caliche in cracks in upper part.

The A11 horizon ranges from 6 to 12 inches in thickness. This horizon, when dry, ranges from dark grayish brown to very dark brown and, in places, to very dark gray. Hue is 10YR, value is 2 to 4, and chroma is 1 or 2. The structure of the A11 horizon is moderate or strong and ranges from granular to prismatic that breaks to subangular blocky or granular. This horizon ranges from neutral to moderately alkaline and has none to strong effervesence when acid is added. About 10 to 50 percent of the surface is covered with stones and limestone fragments, most of them less than 10 inches across but some ranging up to as much as 3 feet or more.

The A12 horizon is clay that ranges from 5 to 10 inches in thickness. It has the same range in color and structure as the A11 horizon, but generally is a little lighter colored and more calcareous and has weaker structure. Limestone fragments occur in this horizon.

The Ccam horizon ranges from a distinct layer about 6 inches thick to a thin coating on limestone fragments. It is generally cemented, but in places it is soft. In some areas it is a thin layer of fine, hard concretions of calcium carbonate that are mixed with limestone fragments. The underlying limestone is several to many feet thick and is generally fractured.

KIMBROUGH SERIES

The Kimbrough series consists of calcareous, grayish-brown gravelly loams that formed in thick beds of hard caliche. The caliche was laid down during Pliocene time as outwash from the Edwards Plateau. Kimbrough soils are in broad, nearly level to undulating areas, mainly in the southern two-thirds of the county. They formed under a cover of mid and short grasses and thorny brush.

Kimbrough soils are closely associated with the Ector, Quemado, Reagan, Tarrant, Uvalde, and Zapata soils. Caliche is very near the surface in the Kimbrough soils, but Ector and Tarrant soils are very shallow over limestone. Kimbrough soils are much more shallow than the Reagan or the Uvalde soils, and they are lighter colored than the Tarrant soils. They are darker colored than the Zapata soils and are less red and more alkaline than the Quemado soils.

Representative profile (100 feet west of Standart Road; 0.4 mile north of U.S. Highway No. 90, about 10 miles west of Brackettville):

A1—0 to 5 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak granular structure; slightly hard when dry, friable when moist; many fine and very fine pores; many fine grass roots; common worm casts; about 40 percent of the soil mass, by volume, is fragments of caliche and limestone, most of them less than 1 centimeter in size but some ranging up to 7 centimeters; same kinds of fragments cover about 40 to 60 percent of the surface; calcareous; pH 8.2; clear boundary.

C1cam—5 to 10 Inches, indurated caliche; about 90 percent of the soil mass is caliche fragments, less than 12 inches across and 3 inches thick; fragments are smooth on top, knobby beneath, laminated in upper one-half inch, and somewhat overlapping each other; soil is around, under, and between these fragments; calcareous; abrupt boundary.

C2—10 to 72 inches +, white (10YR 8/2) massive caliche that becomes nodular at depths below 20 inches; very pale brown (10YR 7/3) when moist; calcareous.

The A1 horizon ranges from 3 to 10 inches in thickness. This horizon, when dry, ranges from grayish brown to dark grayish brown. Its value is darker than 3.5 when the horizon is moist. Structure is weak or moderate and ranges from granular to subangular blocky. The A1 horizon ranges from loam to clay loam. The fragments of limestone and caliche in this horizon are 5 to 50 percent of the volume.

The C1cam horizon generally ranges from 2 to 6 inches in thickness, but in places it is as thick as 18 inches.

The soil material between the caliche plates ranges from less than 5 to about 20 percent of the horizon. In places gravel is imbedded in the cemented caliche.

The C2 horizon is generally several feet thick, but in many places where the Kimbrough soils occur with the Ector soils it is only 6 inches thick and is underlain by limestone or chalk.

KNIPPA SERIES

This Knippa series consists of deep, firm silty clays that are dark colored and well drained (fig.17). These soils formed in smooth, nearly level valleys that average 1/2 mile in width and are about 3 or 4 miles long. These valleys extend from the foot slopes of the Edwards Plateau to the Rio Grande Plain. The parent material of the Knippa soils is calcareous, clayey outwash that was brought in from the Edwards Plateau during Pleistocene time. These soils formed under a cover of mid and short grasses and a thin overstory of thorny brush, mainly mesquite.

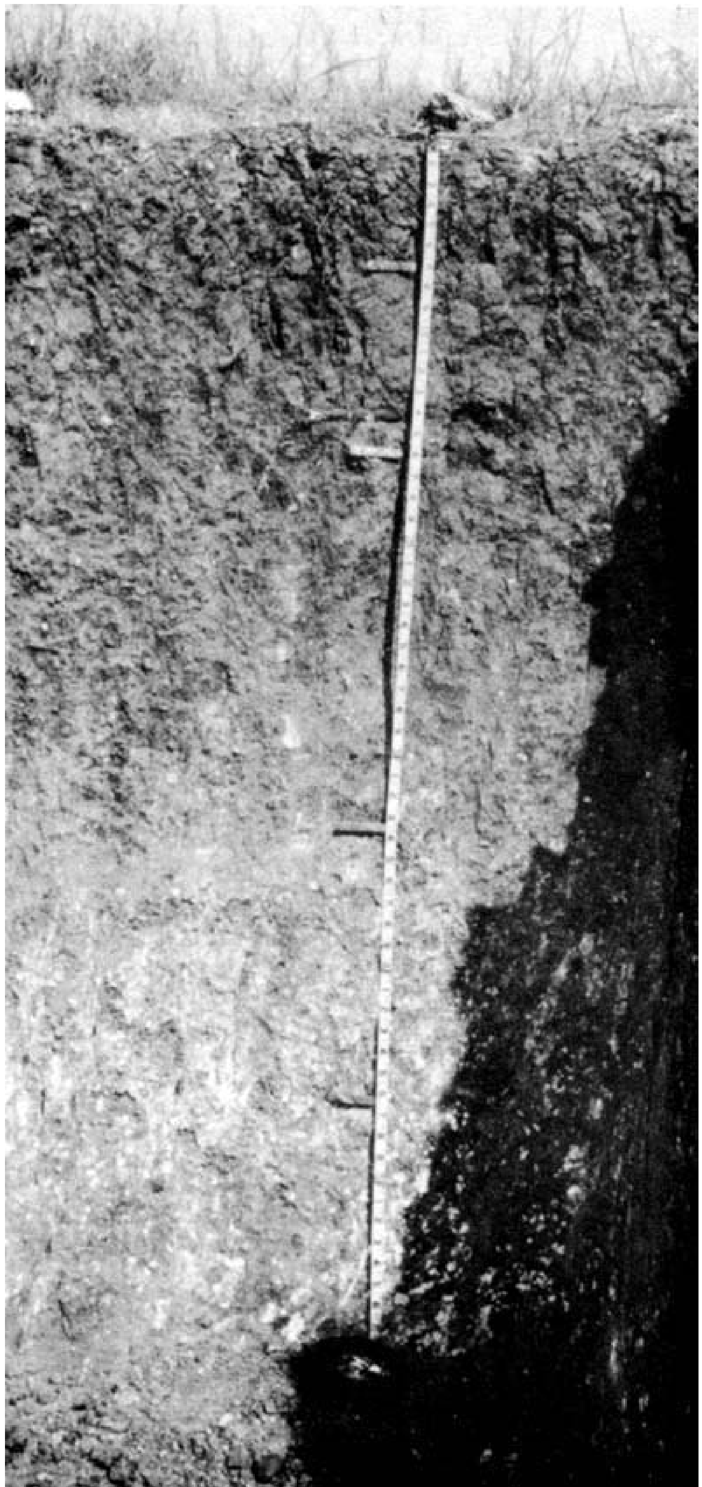

Figure 17.—Profile of Knippa silty clay.

Knippa soils are closely associated with the Kimbrough, Montell, and Uvalde soils. They are much deeper than the Kimbrough soils, are not so gray as the Montell soils, and are more clayey than the Uvalde soils. Representative profile in a nearly level valley between ridges of Kimbrough soils (6.8 miles north of Brackettville on Farm Road 674, about 800 feet north and 100 feet east of entrance to Shahan Ranch):

A11—0 to 8 inches, grayish-brown (10YR 4.5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; weak subangular blocky structure; firm when moist, very hard when dry; common grass roots; few worm casts; few fine pores and old root channels; few fragments of snail shells; few limestone fragments less than 2 centimeters across; calcareous; pH 82; gradual, smooth boundary.

A12—8 to 19 inches, grayish-brown (10YR 4.5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine and very fine, blocky structure; firm when moist, very hard when dry; common grass roots; few fine pores and old root channels; some staining of organic matter around old root channels and on some ped surfaces; few fragments of snail shells; few limestone fragments less than 2 centimeters across; many hard concretions of calcium carbonate less than 2 millimeters in diameter; calcareous; pH 8.2; gradual, wavy boundary.

B2—19 to 41 inches, brown (7.5YR 5/2) clay, dark brown (7.5Y R 4/2) when moist; weak to moderate, fine and very fine, blocky structure; firm when moist, very hard when dry; few roots: few worm casts; organic stains on some ped surfaces; about 3 percent of the soil mass, by volume, is soft and hard concretions of calcium carbonate less than 2 millimeters in diameter; few limestone fragments less than 2 centimeters in diameter; calcareous; pH 8.2; diffuse, wavy boundary.

C1ca—11 to 55 inches, light yellowish-brown (10YR 6/4) clay, yellowish brown (10YR 5/4) when moist; friable when moist, very hard when dry; few worm casts; few limestone fragments as much as 2 centimeters in size, most of which are less than 5 millimeters in diameter; about 10 to 15 percent of the soil mass is soft lumps of calcium carbonate less than 5 millimeters in size and a few hard concretions of calcium carbonate less than 3 millimeters in size; calcareous; pH 8.2; diffuse, wavy boundary.

C2—55 to 72 inches +, yellowish-brown (10YR 5/4) clay, same color when moist; friable when moist, very hard when dry; few fragments of snail shells; about 5 to 10 percent of the soil mass is soft lumps of calcium carbonate about 1 centimeter in diameter; few hard concretions of calcium carbonate less than 3 millimeters in size; few limestone fragments, most of which are less than 2 centimeters across; calcareous; pH 8.2.

The A11 horizon ranges from 6 to 10 inches in thickness. It ranges from dark grayish brown to brown and has a hue of 7.5YR to 10YR, value of 3 to 5, and chroma of 2 or 3. Structure is weak and ranges from subangular blocky to granular. In the A1 horizon, the content of clay ranges from 45 to 60 percent, and the content of silt generally is more than 30 percent.

The A12 horizon ranges from 6 to 18 inches in thickness. The range in color and texture is the same as for the A11 horizon. Structure ranges from moderate, medium to very fine, blocky to moderate and strong, granular and subangular blocky.

The B2 horizon ranges from 12 to 30 inches in thickness. This layer ranges from reddish brown to brown and has a hue ranging from 5YR to 10YR, a value of 4 or 5, and a chroma of 2 or 3. Structure is weaker than that in the A12 horizon.

The C1ca horizon ranges from faint to strong. Its color ranges from very pale brown to yellowish brown but is reddish yellow in places. Thickness ranges from 6 to

18 inches. The calcium carbonate equivalent averages between 10 and 15 percent but is as much as 30 percent in places.

The C horizon ranges from very pale brown to yellowish brown. The material generally is clay, but in places it is gravelly. The percentage of calcium carbonate is generally less than 10.

Throughout the profile the pH ranges from 7.8 to 8.2. The electrical conductivity of the saturation extract is less than 1 millimho per centimeter.

MONTELL SERIES

The Montell series consists of deep, very firm, gray clays on old alluvial fiats. These soils formed in calcareous, unconsolidated clayey sediment that was deposited as outwash during Pleistocene time. They occur on broad, smooth, nearly level areas where gilgai microrelief is faint to distinct. These soils formed under a cover of short grasses and a thin overstory of thorny brush.

Montell soils are more clayey and more gray than closely associated Uvalde silty clay loam. They are grayer than Knippa silty clay.

The representative profile that follows is 2 miles south of Spofford, 100 feet east of the intersection of State Route 131 and Farm Road 1908. The microdepressions are 2 to 6 inches deep, 6 to 12 feet wide, and 10 to 30 feet apart. The vegetation in the depressions is a sparse stand of Texas bristlegrass, plains bristlegrass, Halls panicum, and tobosa. Vegetation on the microknolls is mostly curly mesquite.

A11—0 to 10 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; weak blocky structure; very firm when moist, very hard when dry; common grass roots; few fine pores and old root channels; few fine fragments of snail shells; calcareous; pH 8.2; gradual boundary.

A12—10 to 30 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; moderate, medium, blocky structure; very firm when moist, extremely hard when dry; few to common grass roots, mostly between peds; few fragments of snail shells; few very fine waterworn fragments of limestone and chert; some organic staining on ped surfaces; distinct slickensides at an angle of 20 to 45 degrees from the horizontal; calcareous; pH 8.2; diffuse boundary.

AC—30 to 43 inches, grayish-brown (10YR 5/1.5) clay, dark grayish brown (10YR 4/1.5) when moist; weak to moderate, medium, blocky structure; firm when moist, very hard when dry; few roots; few old root channels; some organic staining on ped surfaces; few, faint, discontinuous slickensides; few fine fragments of limestone and chert; few fragments of snail shells; few calcium carbonate concretions less than 2 millimeters in diameter; calcareous; pH 8.2; moderately saline; diffuse boundary.

C1ca—43 to 56 inches, pale-brown (10YR 6.5/3) clay, brown (10YR 5.5/3) when moist; firm when moist, very hard when dry; about 5 percent of the soil mass, by volume, is soft lumps of calcium carbonate less than 5 millimeters in diameter; about 5 percent is neutral salts in threads and pockets less than 5 millimeters in diameter; some organic staining along old root channels; calcareous; pH 8.2; moderately saline; diffuse boundary.

C2—56 to 72 inches +, pale-brown (10YR 6.5/3) clay, brown (10YR 5.5/3) when moist; firm when moist, very hard when dry; about 15 to 20 percent is segregated salt threads and pockets as much as 1 centimeter in diameter; about 10 percent, by volume, is gypsum crystals, most of which are scattered throughout clay material, but some fill pockets as much as 4 centimeters in diameter; few, medium, distinct, strong-brown (7.5YR 5/6) mottles; calcareous; pH 8.2; moderately saline.

The A11 horizon ranges from 4 to 12 inches in thickness. It is gray to very dark gray. Structure is weak and ranges from blocky to subangular blocky. The A12 horizon ranges from 10 to 25 inches in thickness and from gray to dark gray in color. Structure is moderate and weak blocky.

The AC horizon ranges from 10 to 20 inches in thickness and from gray to light brownish gray in color. Structure ranges from blocky to almost massive.

Depth to the C1ca horizon ranges from 30 to 50 inches. This horizon ranges from 6 to 18 inches in thickness and from light gray to pale brown in color. The content of calcium carbonate ranges from 5 to 20 percent. Gypsum crystals range from none to about 10 percent of the horizon. The C2 horizon is about the same color as the C1ca horizon. It contains less calcium carbonate than the C1ca horizon but in most places contains more gypsum and neutral salts.

Throughout the profile the pH ranges from 7.9 to 8.2. The electrical conductivity of the saturation extract is generally less than 2 millimhos per centimeter to a depth of 24 inches. Below this depth electrical conductivity increases sharply and is about 8 to 20 millimhos in the Cca horizon, which means that salinity in the Cca horizon ranges from moderate to strong.

In dry areas cracks 1 to 2 inches in width are common. These cracks extend downward to the Cca horizon at an angle of 5 to 10 degrees from the vertical.

A common feature of Montell clay is faint to distinct slickensides, 2 to 8 inches across, that are tilted at an angle of 20 to 45 degrees from the horizontal.

PINTAS SERIES

The Pintas series consists of moderately deep, friable, dark-colored soils on bottom lands that are frequently flooded. These calcareous soils are in narrow bands along spring-fed streams. Slopes are smooth and nearly level to gentle. The parent material consists of silty and loamy sediment that washed from soils formed on limestone. A high water table has deposited a thick layer of calcium carbonate about 20 to 30 inches below the surface. Beds of water-bearing gravel are generally within 6 to 10 feet of the surface. These soils formed under a cover of tall grasses, live oaks, and pecan trees.

Pintas soils are closely associated with Frio soils, which do not have a thick layer of calcium carbonate.

Representative profile on slope of 11/2 percent (on west side of Las Moras Creek, 1.5 miles south of U.S. Highway No. 90, on State Highway No. 131; three-fourths mile west of highway):

A1—0 to 14 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak and moderate, fine and very fine, granular structure; hard when dry, friable when moist; common pores; few cavities; few grass roots, many small roots of trees; few snail shells; few very fine concretions of calcium carbonate; calcareous; pH 8.0; gradual boundary.

B2—14 to 26 inches, light brownish-gray (10YR 6/1.5) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, very fine, granular structure; slightly hard when dry, friable when moist; common fine pores; few cavities; few grass roots, many small roots of trees; few snail shells; few very fine concretions of calcium carbonate; calcareous; pH 8.0; gradual boundary.

Cca—26 to 60 inches +, white (10YR 8/2) light silty clay loam or loam, very pale brown (10YR. 8/3) when moist; porous; few hard concretions of calcium carbonate; estimated 40 to 60 percent calcium carbonate equivalent, by volume; calcareous; pH 8.2.

The A1 horizon ranges from 10 to 18 inches in thickness. It is dark grayish brown to black and has a hue of 10YR, value of 2 to 4, and chroma of 1 or 2. Structure ranges from granular to subangular blocky and is weak or moderate and fine or very fine. A thin 01 horizon occurs in many places.

The B2 horizon ranges from 8 to 24 inches in thickness. This horizon, when dry, ranges from grayish brown to light brownish gray. It is silty clay loam to silty clay or clay loam.

The Cca horizon ranges from 24 to more than 100 inches in thickness and from white to light brownish gray in color. Beds of water-bearing gravel occur below the Cca horizon.

QUEMADO SERIES

The Quemado series consists of very gravelly, very shallow and shallow soils that are neutral to moderately alkaline. These gently sloping to sloping areas formed in soils in old gravelly alluvium of mixed origin that was deposited near the Rio Grande and now forms high terraces. Quemado soils are 100 to 200 feet higher than the river channel. They formed under a thin cover of mid and short grasses and thorny brush.

Quemado soils are closely associated with but are redder than Jimenez soils. Also, Quemado soils are leached of lime, and Jimenez soils are not. Quemado soils are darker colored than Zapata soils, which are calcareous instead of neutral to moderately alkaline.

Representative profile (about 10 miles southeast of Del Rio; 1.6 miles west of U.S. Highway No. 277, on road of Maverick County Canal Headgate; 100 feet south of road in pasture):

A1—0 to 4 inches, dark-brown (7.5YR 4/4) very gravelly sandy loam, dark brown (7.5YR 3/4) when moist; weak granular structure; slightly hard when dry, friable when moist; 50 percent of horizon, by volume, consists of waterworn pebbles of quartz, chert, sandstone, limestone, and igneous rock, mostly less than 7 centimeters in diameter; neutral; clear boundary.

B2—1 to 12 inches, reddish-brown (5YR 4/4), very gravelly sandy loam that is slightly more clayey than the A1 horizon, dark reddish brown (5YR 3/4) when moist; weak granular structure; slightly hard when dry, friable when moist; few faint clay films in lower part; 70 percent of horizon is waterworn pebbles of the same kind as in the A1 horizon; neutral; abrupt boundary.

C1cam—12 to 24 inches, pinkish-white (7.5YR 8/2) strongly cemented caliche, finely laminated and indurated in upper part; about 50 percent of horizon is rounded gravel; few fractures; diffuse, irregular boundary.

C2—24 to 60 inches +, pinkish-white (7.5YR 8/2), weakly cemented caliche and rounded pebbles in about equal parts.

The A1 horizon ranges from 3 to 6 inches in thickness. This horizon is dark brown to brown or reddish brown in a hue of 7.5YR or 5YR. When the A1 horizon is moist, value is less than 3.5. This horizon ranges from gravelly sandy loam to gravelly loam. It is neutral or mildly alkaline.

The B2 horizon ranges from 3 to 9 inches in thickness. It is brown or reddish brown, and chroma is slightly higher than that of the A1 horizon. If the gravel is excluded, texture ranges from sandy loam to light sandy clay loam or loam. The content of gravel ranges from 40 to 70 percent, by volume. The B2 horizon ranges from neutral to mildly alkaline.

The top of the C1cam horizon is smooth in most places but. finely etched. The upper 1/4 to 1/2 inch is finely laminated. In the upper few inches, induration ranges from moderate to strong but commonly the caliche is fractured into plates. The

gravelly C2 horizon ranges from 3 to 20 feet in thickness and overlies limestone or calcareous clay and shale.

REAGAN SERIES

This series consists of moderately deep, friable soils that are light brownish gray and calcareous. These soils formed in a thin mantle of loamy and silty outwash over soft, chalky material. They are most common on gently sloping foot slopes on the northern side of the Anacacho Mountains and on slope breaks in the southwestern part of the county that extend to creeks. They formed under a thin cover of mid and short grasses and an overstory of guajillo, mesquite, and other thorny brush.

The Reagan soils are lighter in color than Uvalde soils. They are deeper than the Kimbrough soils and do not have a layer of indurated caliche.

Representative profile (about 3 miles east of the Anacacho Ranch airstrip, about 20 miles southwest of Brackettville):

A1—0 to 10 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak subangular blocky and granular structure; hard when dry, friable when moist; surface has soft crust, one-fourth inch thick, that is light gray (10YR 7/2) when dry; few small pebbles of caliche and limestone; few fragments of snail shells; many fine pores; common worm casts; calcareous; gradual boundary.

B2—10 to 24 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak subangular blocky and granular structure; bard when dry, friable when moist; few small pebbles of caliche and limestone; threads of calcium carbonate on ped surfaces; many fine pores; common worm casts; calcareous; clear boundary.

C1ca—24 to 32 inches, very pale brown (10YR 8/3) clay loam. pale brown (10YR 6/3) when moist; hard when dry, friable when moist; calcium carbonate makes up 30 to 40 percent of soil mass, by volume; few hard concretions; calcareous; gradual boundary.

IIC2—32 to 45 inches, white (10YR 8/2) silt loam and clay loam that appears to be soft chalk; *very* pale brown (10YR 8/3) when crushed and very pale brown (10YR 7/3) when moist; calcareous; gradual boundary.

IIC3—45 to 60 inches, pale-yellow (2.5Y 9/4) silt loam, pale yellow (2.5Y 7/4) when moist; soft chalk in thin layers.

The A1 horizon ranges from 6 to 14 inches in thickness. This horizon, when dry, ranges from light brownish gray to grayish brown and has a hue of 10YR, a value of 5 or 6, and a chroma of 2 or 3. Value of moist material is 4 or 5. Structure is weak or moderate, fine and medium, and granular to subangular blocky. In some places fragments of watergrown limestone make up as much as 3 percent of this horizon.

The B2 horizon ranges from 10 to 22 inches in thickness. It ranges from pale brown to very pale brown but in places is light brownish gray. Structure ranges from weak granular to subangular blocky. Waterworn pebbles and cobbles may occur in the B2 horizon, and in some areas they are in a distinct, though discontinuous, layer.

The Cca horizon ranges from 6 to 18 inches in thickness. It is white to very pale brown. The calcium carbonate equivalent ranges from 20 to 50 percent, by volume. The C horizon ranges from white to pale yellow. It generally consists of layers of hard and soft powdery chalk but ill places is thick beds of soft chalk.

TARRANT SERIES

This series consists of dark grayish-brown to black, stony soils that are very shallow over hard, fractured limestone. These soils formed in undulating to hilly areas under tall and mid grasses and small trees and brush.

Tarrant soils are closely associated with the Ector and Kavett soils. They are darker colored and more clayey than the Ector soils and are more shallow than the Kavett soils. Tarrant soils do not have a caliche layer, as do the Kimbrough soils.

Representative profile (about 12 miles north of Brackettville on Farm Road 674, 0.4 mile south of entrance to Moody Ranch):

A1—0 to 5 inches, black (10YR 2/1) clay, same color when moist; moderate, very flee, granular structure; very hard when dry, friable when moist; many very fine roots; few pores; few worm casts; about 50 percent of the surface is covered by boulders, stones, cobbles, and pebbles of limestone; about 25 percent of the layer, by volume, is pebbles and cobbles; calcareous; pH 8.0; clear boundary.

R&A—5 to 8 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; more than 90 percent is limestone the size of stones, cobbles, and pebbles; soil material is between these rocks; moderate, very fine, granular structure; hard when dry, friable when moist; few worm casts; calcareous; pH 8.0; abrupt boundary.

R—8 inches +, white limestone bedrock, several to many feet thick, that is fractured or fissured; thin seams of soil are in some fractures in which roots are present.

The A1 horizon ranges from 2 to 12 inches in thickness; average thickness is about 5 or 6 inches. This horizon, when dry, ranges from dark gray to very dark brown and has a hue of 10YR, value of 2 to 4, and chroma of 1 or 2. Structure ranges from weak to strong, very fine to medium, granular and in places is subangular blocky. The A1 horizon is generally clay, but it ranges to heavy clay loam. It is neutral to moderately alkaline. Effervescence, when acid is added, is none to strong. About 40 to 75 percent of the surface is covered by fragments of limestone and stones. Most of the fragments are 3 to 8 inches across, but some are as much as 3 feet.

The R&A horizon ranges from 2 to 5 inches in thickness, but it is missing in some places. This horizon, when dry, ranges from light brown to very dark grayish brown. Generally, more limestone fragments are in the R&A horizon than are in the A1 horizon. The underlying limestone is several to many feet thick and is generally fractured.

UVALDE SERIES

This series consists of deep, friable silty clay loams that are dark grayish brown and calcareous. These soils formed in alluvium on broad, smooth, nearly level to gently sloping old alluvial flats and high stream terraces, mainly in the southern two-thirds of the county. The parent material consists of unconsolidated, silty and loamy sediments of out wash brought in from the Edwards Plateau during Pleistocene time. These soils formed under mid and short grasses and a thin overstory of thorny brush.

Uvalde soils are closely associated with the Frio, Kimbrough, Knippa, Montell, and Reagan soils. These soils have a much more distinct layer of calcium carbonate than the Frio soils. They are much deeper than the Kimbrough soils and, unlike them, lack a hard layer of caliche. Uvalde soils are much less clayey than the Knippa and Montell soils, are not so gray as the Montell soils, and are darker colored than the Reagan soils.

Representative profile of Uvalde silty clay loam where slope is less than one-half percent (about 2 miles west of Brackettville on U.S. Highway No. 90; about 5 miles southwest on Farm Road 693; 1.2 miles west on lane to headquarters of Kerr Ranch; 100 feet northwest of gate on north side of lane):

A11—0 to 6 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 2.5/2) when moist; surface has soft crust 1

centimeter thick: weak granular and subangular blocky structure; friable when moist, slightly hard when dry; few worm casts; common fine roots and old root channels; few fragments of snail shells; calcareous; pH 8.2; gradual, smooth boundary.

A12—6 to 17 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak subangular blocky and granular structure; friable when moist, hard when dry; few fine pores and worm casts; few old root channels; calcareous; pH 8.2; gradual, smooth boundary.

B2—17 to 27 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak subangular blocky structure; friable when moist, hard when dry; few fine pores and old root channels; few worm casts; few patchy, indistinct clay films few fragments of snail shells; calcareous; pH 8.2; clear, wavy boundary.

C1ca—27 to 38 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; friable when moist, hard when dry; about 20 to 25 percent of soil mass, by volume, is soft calcium carbonate; calcareous; pH 8.2; gradual, wavy boundary.

C2—38 to 72 inches +, light-brown (7.5YR 6/4) silty clay loam, brown (7,5YR 5/4) when moist; friable when moist, hard when dry; about 15 to 20 percent of soil mass is lumps of calcium carbonate; calcareous; pH 8.2.

The A11 horizon ranges from 5 to 10 inches in thickness. It is grayish brown to dark grayish brown. Structure ranges from weak or moderate, fine and medium, granular to subangular blocky. The A12 horizon ranges from 8 to 15 inches in thickness. Its color is the same as that of the A11 horizon. Structure generally ranges from moderate, fine and medium, granular to subangular blocky, but in places it is very fine blocky. The total thickness of the A11 and A12 horizons averages about 15 inches.

The B2 horizon ranges from 8 to 15 inches in thickness. It is grayish brown to pale brown. Structure ranges from weak to moderate, fine, granular to weak subangular blocky.

The C1ca horizon generally ranges from 6 to 18 inches, but in places it is as much as 30 inches thick. This horizon is very pale brown to light brown. In most places the calcium carbonate equivalent ranges from 5 to 30 percent, by volume, but in the thicker C1ca horizons it is 40 or 50 percent.

The C2 horizon is a little darker in color than the C1ca horizon and contains less calcium carbonate. Normally the calcium carbonate amounts to 10 to 15 percent in the C2 horizon and 20 to 25 percent in the C1ca. In many places waterworn pebbles are numerous in the C2 horizon.

ZAPATA SERIES

This series consists of light-colored, calcareous, gravelly lams that are very shallow over thick beds of hard caliche. The caliche was deposited as outwash brought in from the Edwards Plateau during Pliocene time. Zapata soils occur on undulating to rolling uplands in the southern part of the county. They formed under a cover of short and mid grasses and thorny brush.

Zapata soils occur closely with Kimbrough soils, which have a gravelly loam surface layer and are darker colored. They are not underlain by limestone, as are the Ector soils. The Zapata soils are more limy and lighter colored than the Quemado soils and are not so deep as the Reagan soils.

Representative profile (100 yards west of farm pond, which is 0.6 mile west and 1.3 miles south of intersection of Farm Road 693 and U.S. Highway No. 277 in the southwestern part of the county):

A1—0 to 8 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) when moist; weak subangular blocky and granular structure; hard when dry, friable when moist; about 55 percent, by volume, is pebbles of waterworn limestone, chert, quartz, sandstone, and igneous rock, most pebbles less than 7 centimeters in diameter; few cobbles; some caliche fragments; calcareous; abrupt boundary.

C1cam—8 to 14 inches, indurated platy caliche that contains embedded pebbles like those in the A1 horizon above; caliche plates are laminar and have smooth upper surfaces and rough, knobby lower surfaces; small amount of soil material between plates; diffuse boundary.

C2—14 to 70 inches +, weakly cemented, massive caliche that becomes nodular and less cemented with depth; 35 to 60 percent, by volume, consists of pebbles, like those in the A1 horizon.

The A1 horizon ranges from 3 to 12 inches in thickness. This horizon, when dry, ranges from light gray to brown and has a hue of 7,5YR and 10YR. Value for moist material is higher than 3.5. Texture ranges from loam to light clay loam or silt loam. Coarse fragments make up 20 to 80 percent of the soil mass and consist of rounded waterworn chert, quartz, sandstone, limestone, and various igneous rocks, or angular caliche.

The C1cam horizon normally ranges from 2 to 6 inches in thickness, but in some areas it is as much as 18 inches thick. In places it contains embedded gravel. The C2 horizon is generally several feet thick, but it is as little as 3 inches thick in places and is underlain by limestone or chalk.

Geomorphology and Geology

In order to better understand the factors of soil formation, especially parent. material and relief, it is best to study the types of terrain and the surface geology that occur in Kinney County. Figure 18 is helpful because it shows the major soils in the county and the formations underlying them.

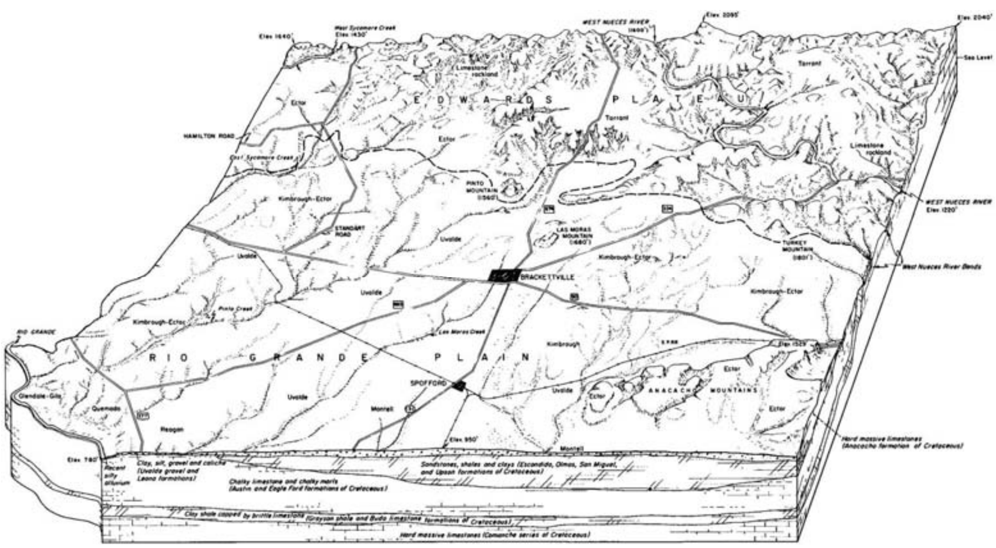

Figure 18.—Major soils and underlying formations.

The northern one-third of Kinney County is a part of the Edwards Plateau, which is a part of the Great Plains. The southern two-thirds is a part of the Gulf Coastal Plain and is usually called the Rio Grande Plain. In Kinney County these physiographic divisions are separated by a moderately low escarpment, known as the Balcones escarpment, or Balcones fault zone.

The Edwards Plateau is underlain by hard limestone, which is highly resistant to erosion. The plateau has an altitude ranging from about 1,500 to 2,000 feet. Numerous streams and their tributaries have cut canyons, as much as 400 feet deep, that dissect the plateau and form mesas, ridges, hills, and deep, narrow valleys. The terrain is rough, and the soils are thin.

Most of the Rio Grande Plain is underlain by soft limestones and marls, which are more easily eroded than the resistant limestone of the Edwards Plateau. Most of the plain is nearly level to gently rolling and has broad ridges, plains, and valleys. The altitude ranges from about 800 to 1,300 feet. The soils are thin on the ridges and thick on the plains and in valleys. Exceptions to the nearly level to gently rolling topography are the igneous hills that rise sharply above the plain. Hills of this kind are Turkey and Las Moras Mountains. They rise 300 to 400 feet above the plain. In the southeastern part of the county, the Anacacho Mountains, about 300 feet high above the plain, is of resistant limestone.

At one time the Coastal Plain extended much farther inland than it does today. After the folding and minor faulting that was part of the Balcones faulting, the deposits of the Upper Cretaceous system (soft limestones) were stripped, and in the Edwards Plateau part of Kinney County, the hard limestone of the Lower Cretaceous system was dissected deeply. The material removed by this erosion was deposited on the Coastal Plain at varying distances from the plateau. Gravel was laid down near the plateau, and silt and clay farther away.

The surface geology of Kinney County consists of sedimentary and igneous rocks. The exposed sedimentary rocks include deposits of Cretaceous, Tertiary, and Quaternary systems. The rocks in the Cretaceous system were deposited under marine conditions, but the material in the Tertiary and Quaternary systems was laid down by fresh water.

The Cretaceous system is divided into the Comanche Lower Cretaceous) and Gulf (Upper Cretaceous) series (*4*). The Comanche series consists of the Fredericksburg and Washita groups, which are further divided into formations. The formations that crop out in Kinney County as hard limestones are Comanche Peak, Edwards, Kiamichi, Georgetown, and Buda. These formations give rise to Tarrant soils and Kavett soils in the Nueces River watershed and to Ector soils in the Rio Grande watershed. The much dissected terrain has steep hills, steep slopes from mesas, and ridges, narrow canyon floors, and many limestone outcrops. The soils are very shallow and stony and, if cover is removed, are easily eroded.

Grayson shale, a formation of the Washita group, is exposed between the limestones in the Georgetown and Buda formations. The Grayson shale turns yellow when it weathers and is in a low, nearly bare north-facing escarpment of badland. It is easily eroded where it is not protected by the overlying Buda limestone. Grayson shale outcrops as a narrow, crooked band that extends from the east side of the county to the northwestern part. Because the band is only about 100 yards wide in Kinney County, it was not mapped separately but was included with the surrounding soil.

The igneous rocks are intrusions of magma into the Cretaceous rocks (*3*). They are mainly sills or dikes of basalt, which is highly resistant to erosion. These rocks app ear in the landscape as steep hills or mountains. The basalt gives rise to Ingram soils, which are stony, shallow, dark-brown clays. Figure 19 shows basalt underlying Ingram stony clay.

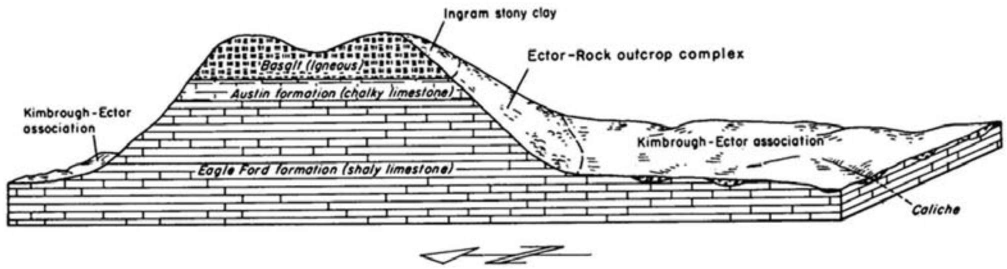

Figure 19.—Soils and underlying rock an Las Moras Mountain.

Eagle Ford and Austin formations are soft, chalky limestones and marls of the Gulf series (Upper Cretaceous system). These formations erode to broad, low hills and ridges. They give rise to Ector and Kimbrough soils and are fairly well covered with caliche that ranges from only a few inches to several feet thick. These soils are very shallow. The chalky limestone lies near the surface of the Ector soils, but a thick bed of caliche overlies the limestone in the Kimbrough soils. Most of the Ector soils are in a band that extends east-to-west through the middle part of the county.

The general dividing line between the Edwards Plateau and the Rio Grande Plain is the aerial contact between the Eagle Ford and Buda formations, which is generally exposed, but in places is covered by broad areas of more recent sediments that give rise to deeper soils. These deeper soils are a part of the Rio Grande Plain.

The Anacacho formation, another member of the Upper Cretaceous system, is made up of hard limestone that contains many fossils, This formation comprises the Anacacho Mountains in the southeastern part of the county. These mountains were probably formed as an offshore reef when much of Kinney County was under water. Very shallow Ector soils have formed on steep slopes having many rock outcrops.

Other formations in the Upper Cretaceous system are the Upson, the San Miguel, the Olmos, and the Escondido. These formations crop out mainly in creek beds and do not give rise to any soils in Kinney County.

The Pliocene series in the Tertiary system is represented in Kinney County by the Uvalde gravel formation. It consists of gravel, well cemented with caliche, and gives rise to very shallow, gravelly soils over hard caliche. Soils developed in this material include the Quemado, the Jimenez, the Kimbrough, and the Zapata. The very gravelly Quemado soils are in broad, gently sloping areas on an ancient terrace of the Rio Grande, 100 to 200 feet above the river channel. The Jimenez and Zapata soils near the Rio Grande are a few feet lower than the Quemado soils. They formed in sediments that are similar to those of the Quemado soils but are slightly older. The surface is deeply dissected and appears quite choppy. Jimenez and Zapata soils formed in sediments that are of mixed origin and include pebbles of quartz, basalt, limestone, sandstone, and chert that have been carried long distances by the Rio Grande.

The caliche from which Kimbrough soils formed precipitated out of fresh water that carried materials mainly from the limestone of the Edwards Plateau. The Uvalde gravel formation, in the form of caliche, mantles much of the southern part of the county, and comprises the oldest and highest terraces in the landscape. Also, some remnants of the Uvalde gravel formation are high on the valley slopes in the Edwards Plateau, more than 100 feet above the flood plain of the West Nueces River. Although the Kimbrough soils formed here, the areas were too small to be mapped separately.

In Kinney County the Pleistocene series of the Quaternary system is represented by the Leona formation. It consists of calcareous silt and clay on broad, flat terraces in position intermediate between the Uvalde gravel formation and the present flood plains of streams. The sediments of the Leona formation were deposited by streams during the middle and upper Pleistocene epoch (Ice Age). The soils that cover broad

areas formed in these materials and are deep, nearly level to gently sloping. In Kinney County these soils are Knippa silty clay, Montell clay, Reagan loam, and Uvalde silty clay loam.

Recent geologic sediments are on all the flood plains of the rivers and creeks. This alluvium consists of silt, sand, clay, gravel, cobbles, and boulders.

The flood plain of the Rio Grande has silty sediments of a mixed origin that were carried a long distance. The soils that formed along this flood plain are Glendale clay loam and Gila loam. These soils are calcareous, deep, and friable, but they are lighter colored than soils on bottom land that were derived chiefly from limestone. They have a smooth surface and are seldom, if ever, flooded. Alluvial land lies next to the river channel, about 20 feet lower than Gila or Glendale soils. It is frequently flooded by the river, and it is subject to deposition and removal of sediments. Sediments are disturbed so often that a soil cannot form. The surface has slight ridges that parallel the river.

The sediments on flood plains of the West Nueces River and of creeks draining the Edwards Plateau and the Rio Grande Plain give rise to deep, dark-colored Pintas silty clay loam, Frio clay loam, and Dev soils. These soils have a smooth, nearly level to gently sloping surface.

Pintas soils occur only along Las Moras, Pinto, and Mud Creeks, which are spring-fed streams that contain limestone water saturated with calcium carbonate. This carbonate precipitated out of the water at the top of the water table, which is 3 to 10 feet below the surface. As a result, a thick, soft carbonate layer formed in the substratum of the Pintas soils. These soils are frequently flooded. Frio soils are a few feet higher on the flood plain than the Pintas soils, and they are not flooded so frequently.

Along some streams, particularly Sycamore Creek and the West Nueces River, the recent alluvium is very gravelly, cobbly, stony, or even bouldery. This alluvium gives rise to Dev soils. In 1940, along Sycamore Creek, a flood resulting from a dying hurricane removed nearly all of the deep, silty material from the flood plain and left limestone rubble of various depths and consisting of fragments of various sizes. Likewise, only limestone rubble remained, when, in 1935, a flood removed a large area of the Frio soils from the flood plain of the West Nueces River. Since then, Dev soils formed in ridges and swales that parallel the stream channel and are frequently flooded.

Climate of Kinney County

By Robert B. Orton, State climatologist, U.S. Weather Bureau, Austin, Texas.

The climate of Kinney County is of the semiarid, continental type; extremes in both rainfall and temperature are large.

Rainfall records for the county date back to 1852, though there were many breaks in the record before 1936. In the 54-year period, 1877 to 1930, the average annual rainfall at Brackettville was 21.71 inches; in the 27-year period, 1936 to 1962, it was 21.12, a remarkably small change in averages for an area where large annual variations do occur. For example, the total precipitation in 1958 (45.37 inches) was twice the annual average, and nearly six times the amount that fell during 1956, a year of drought. Precipitation data, by month, are given in table 7 for a 27-year period ending in 1962.

In Kinney County, as in most of Texas, rains occur most frequently as the result of thunderstorms, the lamest amounts usually falling late in spring and early in summer. Approximately three-fourths of the total annual rainfall occurs in the warmer period, May through October. The most intense storms occur when hurricanes or tropical disturbances occasionally move inland from the Gulf of Mexico during September and October and break up along the escarpment of Edwards Plateau.

Rainfall usually drops off rather sharply as fall progresses from October into November.

It is unusual for an entire month to pass without some measurable precipitation, though the amount may be small. During 1954, however, no measurable rain fell in February, March, November, or December. The driest period on record occurred during the winter of 1917-18, when only 0.03 inch fell in the 6-month period, October through March. The wettest month on record is December 1857. A total of 23.02 inches fell during this month, which is more than the average rainfall for an entire year. The fact that December is usually a compartively dry month makes this occurrence even more remarkable. The driest period on record, extending over a number of years, was 1951-53. A total of 37.09 inches fell during this 3-year period. This drought was soon followed by a 3-year wet period, 1957-59, during which 107.09 inches fell. In 50 percent of the years an annual rainfall of about 19 inches can be expected.

Kinney County enjoys seasonal temperature changes, but its climate is milder in winter than that of areas to the north and east. Cold fronts move down through the area late in fall, in winter, and early in spring, but the most severe weather usually passes off to the east through the central and eastern parts of Texas. Most of these cold fronts are considerably modified by the time they reach Kinney County. January is the coldest month and has an average daily minimum temperature of about 39° F. and an average daily maximum of about 63°. Summer maximum temperatures are high; readings of 100° or above are common in July and August. The average daily maximum temperature during July is about 96°. The longterm mean annual temperature is about 69°

The prevailing winds are from the southeast through all seasons of the year. Average wind velocity, generally below 10 miles per hour, is less than it is in most sections of Texas.

Relative humidity averages about 60 percent annually. It does not vary significantly from month to month, except during March and April, and again in August. During these months the mean relative humidity drops to about 50 percent. This low humidity results in rapid radiational cooling at night, and large differences between daily maximum and minimum temperatures, both in summer and in winter.

The mean (or average) annual amount of sunshine is about 65 percent of the total possible. The most cloudiness occurs in January.

Kinney County enjoys a long growing season that averages about 275 days. The average number of days between the last occurrence of 28° in the spring and the first occurrence of 28° in the fall is 305 days. The average date of the last freezing temperature of 32° in the spring is March 1, and there is 1 chance in 20 that a freeze will occur after March 31. The average date of the first freezing temperature of 32° in the fall is December 1, and there is 1 chance in 20 that a freeze will occur before November 6. Because elevations differ and the terrain is rough, these averages vary locally.

Evaporation is almost as high as it is in any part of Texas. Average annual evaporation from a Weather Bureau 48-inch pan is approximately 110 inches. Of this amount, approximately 69 percent evaporates during the period, May through October. Average annual evaporation from lakes is approximately 76 inches.

Effect of Climate on Agriculture

The climate of Kinney County creates a condition favorable for a climax vegetation of short, mid, and tall grasses. The pattern of rainfall encourages the establishment and spread of subtropical thorny brush. The climax grasses are of the warm-season type because moisture is favorable during the long, warm growing season. Invading weeds are of both warm and cool season types. Warm-season plants become at least semidormant in winter and often in the hot midsummer.

The two periods of major growth are spring (March-June) and fall (September-October). Growth rates are low in midsummer and winter because temperature is high and rainfall is low. Plants grow about the same in spring as they do in fall.

Because winters are mild, sheep, cattle, and goats can graze all year on the open range. Very little supplemental feed is needed, except during long droughts or when the range is overgrazed.

On overgrazed range or ranges in poor condition, rams of high intensity result in severe sheet erosion. This erosion is especially damaging on the very shallow soils.

Low erratic rainfall and high evaporation make dryland farming extremely hazardous. Because the growing season is long, a wide variety of irrigation crops may be grown. In some places two crops can be grown in a year.

In relation to the size of their drainage areas, the West Nueces River, Sycamore Creek, and similar streams in the county, have about as high a discharge rate as any stream in the United States. This is a result of intense rains falling on steep slopes that have thin soils and little vegetative cover. These storms, though infrequent, cause severe sheet erosion and stream scouring. They are particularly damaging after droughts when plant cover is sparse. Sometimes many sheep and goats are drowned, and bottom lands are washed away or covered over with stony debris.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Alkaline soil. A soil that is alkaline through most or all of the parts occupied by plant roots. Practically, a soil having a pH higher than 7.3.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Available water capacity. The capacity of a sail to hold water in a form available to plants. It is the amount of moisture held in the soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are--

Loose.—Noncoherent; soil does not hold together in a mass.

Friable.—When moist, soil crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, soil crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, soil is readily deformed by moderate pressure but can be pressed into a lump, will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, soil adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, soil is moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, soil breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Genesis, soil. The formation of a soil. In describing the manner in which a soil formed, special reference is made to the processes responsible for the development of the solum, or true soil, from the unconsolidated parent material.

Gilgai. Microrelief of clays that expand or contract a great deal when content of moisture changes; normally a succession of microbasins and microknolls, in nearly level areas, or of microvalleys and microridges that run with the slope.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. The A horizon is a mineral horizon at the surface; the B is a horizon where clay and other material have accumulated; and the C horizon is unconsolidated material immediately under the true soil. Collectively, the horizons in a soil are called the soil profile.

Inclusion. An area of soil that has been included in the mapping unit of a soil of a different kind.

Marl. An earthy, unconsolidated deposit formed in freshwater lakes that consists chiefly of calcium carbonate mixed with various amounts of clay or other impurities.

Microrelief. Minor surface configurations of the land.

Morphology, soil. The makeup of the soil, including the texture, structure, consistence, color, and other physical, mineralogical, and biological properties of the various horizons of the soil profile.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4, or light yellowish brown.

Natural drainage. Conditions of drainage that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Parent material. The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Parent rock. A term used for rock from which the parent material was formed by weathering.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: very slow, slow, moderately slaw, moderate, moderately rapid, rapid, and very rapid.

Ph value. See Reaction,

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See Horizon.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excessive exchangeable sodium.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal

forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are (1) single grain (each grain by itself, as in dune sand), or (2) massive (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Surface layer. The layer or layers above the B horizon, or if the B horizon is missing, the C horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called *second bottoms*, as contrasted to *flood plains*, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silly clay loam, sandy clay, silty clay, and clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine" or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, ordinarily rich in organic matter used to topdress roadbanks, lawns, and gardens.

Upland (geological). Land consisting of material unworked by water in recent geologic time and, in general, lying at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Tables

The tables in this soil survey contain information that affects land use planning in this survey area. More current data tables may be available from the Web Soil Survey at the Tabular Data tab.

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TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil or land type	Acres	Percent
Anthony and Glendale soils	5,640	0.4
Badland	940	.1
Boracho-Espy association, gently sloping	54,800	3.8
Brewster-Rock outcrop association, steep	107,100	7.4
Brewster association, hilly	242,620	16.8
Canutio-Badland association, rolling	8,520	.6
Canutio-Nickel association, rolling	9,000	.6
Chispa-Nickel association, undulating	21,300	1.5
Ector association, hilly	14,600	1.0
Gageby association	32,230	2.2
Gullied land	2,370	.2
Hodgins clay loam, 0 to 1 percent slopes	5,250	.4
Hurds-Friends association, rolling	8,220	.6
Ima-Hodgins association, gently sloping	6,480	.4
Kokernot-Brewster association, gently sloping	11,520	.8
Limpia and Mitre soils, gently sloping	36,410	2.5
Liv-Mainstay-Rock outcrop association, steep	124,490	8.6
Loghouse association, rolling	6,450	.4
Lozier association, undulating	8,450	.6
Lozier-Rock outcrop association, hilly	3,900	.3
Mainstay-Brewster association, hilly	148,980	10.3
Musquiz association	99,440	6.9
Nickel-Chispa association, undulating	34,060	2.4
Phantom association	30,770	2.1
Puerta-Madrone association, steep	24,120	1.7
Reagan-Hodgins association	44,480	3.1
Redona association	61,270	4.2
Rockhouse association	25,700	1.8
Rockhouse-Gageby association	17,530	1.2
Rock outcrop-Brewster association, steep	38,210	2.6
Sanderson-Upton association, undulating	6,400	.4
Santo Tomas-Medley association, gently sloping	83,730	5.8
Sproul-Mainstay association, gently sloping	8,920	.6
Vado-Redona association, undulating	18,580	1.3
Verhalen clay	31,250	2.2
Verhalen clay, depressional	560	([1])
Verhalen-Dalby association	31,810	2.2
Vieja-Nickel association, hilly	12,360	.8
Volco association, hilly	17,300	1.2
Total soil or land type	1,445,760	100.0
Total area in county	1,445,760	100.0

[1] Less than 0.05 percent.

TABLE 2.—*Ratings of soils for ponderosa pine*

Soil series and map symbols	Potential productivity		Concerns of management			Woodland suitability group
	Site index	Site rating	Water erosion hazard	Equipment restrictions	Seedling mortality	
Loghouse: LsD	77	High	Moderate	Moderate	Moderate	2x2
Madrone Mapped only in association with Puerta soils.	66	Moderate	Severe	Severe	Moderate (severe if slopes are facing south).	3x3
Puerta: PmF	51	Low	Severe	Severe	Moderate (severe if slopes are facing south).	5x3

TABLE 3.—*Estimates of*

[Absence of value indicates

Soil name	Depth from surface	Classification		
		USDA texture	Unified	AASHO
	Inches			
Alluvial land (Al).	(2)	Stratified material, dominantly sandy loam, silt loam, and loamy sand.	SM or SP	A-2
Dev soils (Ds) (0 to 2 percent slopes).	(2)	Mixed alluvium of clayey to silty material and pebbles.	SP-GP	A-2
Ector soils (Ec) (1 to 20 percent slopes).	0-8	Stony loam	SC	A-2 or A-4
	8-12	Limestone fragments		
	12-18+	Limestone		
Ector-Rock outcrop complex (Et) (5 to 20 percent slopes). Properties are for Ector soil only.	0-5	Stony clay loam	SC or CL	A-4 or A-6
	5-10	Limestone fragments		
	10-20+	Limestone		
Frio clay loam (Fr) (0 to 1 percent slopes).	0-22	Clay loam	CL	A-6 or A-7
	22-38	Clay loam	CL	A-6 or A-7
	38-70	Clay loam	CL	A-6 or A-7
Gila loam (Gm) (0 to 1 percent slopes).	0-60	Loam	ML or SM	A-4
Glendale clay loam (Gc) (0 to 1 percent slopes).	0-24	Clay loam	CL	A-6 or A-7
	24-40	Clay loam	CL	A-6 or A-7
	40-62	Clay loam	CL	A-6 or A-7
Ingram stony clay (In) (5 to 20 percent slopes).	0-12	Stony clay	GC or SC	A-2 or A-6
	12-18	Clay	GC or SC	A-2 or A-6
	18-20	Caliche		
	20-36+	Basalt		
Kavett-Tarrant stony clays (Kc) (0 to 3 percent slopes). Properties are for Kavett soil; for properties of Tarrant soil, see the mapping unit Tarrant soils.	0-15	Stony clay	CL	A-6 or A-7
	15-18	Caliche		
	18-24+	Limestone		
Kimbrough-Ector association (Ke) (1 to 8 percent slopes). Properties are for Ector soil; for properties of Kimbrough soil, see the mapping unit Kimbrough soils.	0-5	Loam	SC	A-2 or A-6
	5-10	Caliche		
	10-60+	Limestone		
Kimbrough soils (Kh) (0 to 2 percent slopes).	0-5	Loam	SC	A-4 or A-6
	5-10	Indurated caliche		
	10-72+	Caliche		

See footnotes at end of table.

properties significant to engineering

estimate was not made]

Percentage passing sieve— No. 4	No. 10	No. 200	Permeability	Available water capacity	Reaction	Shrink-swell potential	Remarks
			Inches per hour	*Inches per inch of soil*	*pH*		
----------	----------	----------	0. 8–4+	0. 06–0. 18	7. 8–8. 2	Low----------	Susceptible to frequent flooding; subirrigation from a high water table in many places.
----------	----------	----------	0. 8–2. 5	0. 04–0. 16	7. 8–8. 2	Low----------	Susceptible to frequent flooding; most areas contain large amounts of water-worn limestone pebbles and large stones.
50–70	40–60	20–40	1. 0–2. 0	0. 10–0. 15	7. 8–8. 2	Low----------	Limestone is fractured into huge slabs.
----------	----------	----------	----------	0. 08–0. 12	7. 8–8. 2	----------	
----------	----------	----------	----------	----------	8. 2	----------	
55–80	50–75	35–55	0. 6–1. 5	0. 10–0. 18	7. 8–8. 2	Moderate-----	Limestone is fractured into huge slabs.
----------	----------	----------	0. 6–1. 5	0. 08–0. 13	7. 8–8. 2	----------	
----------	----------	----------	----------	----------	8. 2	----------	
95–100	95–100	85–95	0. 8–1. 5	0. 17–0. 20	7. 8–8. 2	Moderate-----	Substratum is stratified gravel, silt, and clay; in some places gravelly material is below depth of 3 feet; infrequent floods are of short duration; water table lies at depth of 6 to 15 feet.
95–100	95–100	85–95	0. 8–1. 5	0. 15–0. 18	7. 8–8. 2	Moderate-----	
95–100	90–100	80–100	0. 8–1. 5	0. 12–0. 16	7. 8–8. 2	Moderate-----	
95–100	95–100	40–60	1. 0–2. 0	0. 11–0. 14	7. 8–8. 2	Low----------	Substratum is same material as surface layer but is finely stratified with silt; water table is below depth of 20 feet; soil is seldom, if ever flooded.
95–100	95–100	85–95	0. 8–1. 5	0. 14–0. 18	7. 8–8. 2	Moderate-----	Substratum is same material as surface layer but is finely stratified with sand, silt, and clay; water table is below depth of 20 feet; soil is seldom, if ever, flooded.
95–100	95–100	85–95	0. 8–1. 5	0. 13–0. 16	7. 8–8. 2	Moderate-----	
95–100	90–100	80–100	0. 8–1. 5	0. 12–0. 15	7. 8–8. 2	Moderate-----	
40–60	30–50	25–40	0. 4–1. 0	0. 10–0. 16	6. 8–8. 0	High----------	Soil occurs on igneous sills or plugs, which are prominent hills, or peaks.
40–60	30–50	25–40	0. 4–1. 0	0. 10–0. 15	7. 0–8. 2	High----------	
----------	----------	----------	0. 4–1. 0	0. 08–0. 12	7. 8–8. 2	----------	
----------	----------	----------	----------	----------	----------	----------	
65–85	60–80	50–70	0. 8–1. 5	0. 17–0. 21	7. 0–8. 0	Moderate-----	Water table is below depth of 20 feet.
----------	----------	----------	0. 8–1. 5	0. 10–0. 14	8. 0–8. 2	Moderate-----	
----------	----------	----------	----------	----------	8. 2	----------	
55–75	50–70	30–50	1. 0–2. 0	0. 10–0. 15	7. 8–8. 2	Low.	
----------	----------	----------	1. 0–2. 0	0. 10–0. 15	7. 8–8. 2	Low.	
----------	----------	----------	----------	----------	8. 2	----------	
55–75	50–70	35–50	1. 0–2. 0	0. 10–0. 15	7. 8–8. 2	Low.	
----------	----------	----------	0. 5–1. 5	----------	7. 8–8. 2	Low.	
----------	----------	----------	----------	----------	8. 2	----------	

217-106—67——3

TABLE 3.—*Estimates of properties*

Soil name [1]	Depth from surface	Classification		
		USDA texture	Unified	AASHO
	Inches			
Jimenez-Zapata association (Jm) (5 to 20 percent slopes). Properties are for both the Jimenez and Zapata soils.	0–7	Gravelly loam	GC	A–1 or A–2
	7–18	Indurated caliche		
	18–60+	Caliche		
Knippa silty clay (Kn) (0 to 1 percent slopes).	0–19	Silty clay	CL or CH	A–7
	19–41	Silty clay	CL or CH	A–7
	41–72	Silty clay	CL or CH	A–7
Limestone rockland (Lr) (20 to 70 percent slopes).	(2)	Clay	CL	A–6
Montell clay (Mc) (0 to 1 percent slopes).	0–10	Clay	CL or CH	A–7
	10–30	Clay	CL or CH	A–7
	30–43	Clay	CL or CH	A–7
	43–72	Clay	CL or CH	A–7
Montell clay, low (Mo) (0 to 1 percent slopes).	0–7	Clay	CL or CH	A–7
	7–21	Clay	CL or CH	A–7
	21–32	Clay	CL or CH	A–7
	32–60	Clay	CL or CH	A–7
Pintas silty clay loam (Pc) (0 to 1 percent slopes).	0–14	Silty clay loam	CL	A–6 or A–7
	14–26	Silty clay loam	CL	A–6 or A–7
	26–60	Silty clay loam	CL	A–6 or A–7
Quemado soils (Qu) (1 to 5 percent slopes).	0–12	Sandy loam	GC	A–1 or A–2
	12–24	Indurated caliche		
	24–60+	Caliche		
Reagan loam (Ra) (0 to 5 percent slopes)	0–10	Heavy loam	CL	A–6
	10–24	Heavy loam	CL	A–6
	24–32	Heavy loam	CL	A–6
	32–60	Heavy loam	CL	A–6
Tarrant-Rock outcrop complex (Tr). Tarrant soils (Ts) (1 to 8 percent slopes). Properties are for Tarrant soils in mapping units Tr and Ts.	0–5	Stony clay	CL	A–6
	5–8	Limestone fragments with clay in fragments.		
	8+	Limestone		
Uvalde silty clay loam (Uv) (0 to 1 percent slopes).	0–17	Silty clay loam	CL	A–6 or A–7
	17–27	Silty clay loam	CL	A–6 or A–7
	27–72	Silty clay loam	CL	A–6 or A–7

[1] Soil descriptions are in section beginning on p. 5.

[2] Variable.

significant to engineering—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Remarks
No. 4	No. 10	No. 200					
			Inches per hour	*Inches per inch of soil*	*pH*		
30–50	20–40	15–30	1. 0–2. 0	0. 10–0. 15	7. 8–8. 2	Low	Caliche and substratum combined are as much as 20 feet thick and contain large amounts of gravel of mixed origin; water table is at a great depth.
---	---	---	---	---	8. 0–8. 2	Low	
---	---	---	---	---	8. 0–8. 2	Low	
90–100	85–100	75–90	0. 4–1. 0	0. 19–0. 22	7. 8–8. 2	High	Below depth of 3½ feet the soil becomes less dense and more limy; in some places substratum is gravelly; water table is below depth of 20 feet.
90–100	85–100	75–90	0. 4–1. 0	0. 17–0. 20	7. 8–8. 2	High	
90–100	80–90	70–85	0. 5–1. 0	0. 12–0. 16	7. 8–8. 2	High	
55–80	50–75	50–60	---	---	7. 5–8. 0	Moderate	Clay occurs in pockets and crevices of rocks.
100	95–100	85–95	0. 05–0. 6	0. 20–0. 24	7. 8–8. 2	High	Below depth of about 3½ feet, the clay contains as much as 15 percent gypsum, and salinity ranges from moderate to severe.
100	95–100	85–95	0. 01–0. 5	0. 17–0. 21	7. 8–8. 2	High	
100	95–100	85–95	0. 01–0. 5	0. 17–0. 20	7. 8–8. 2	High	
100	95–100	75–90	0. 1 –0. 7	0. 10–0. 18	7. 8–8. 2	High	
100	95–100	85–95	0. 05–0. 6	0. 20–0. 24	7. 8–8. 2	High	Below depth of 2 feet, salinity is very severe; after occasional heavy rainfall, fluctuating water table is within 2 feet of the surface.
100	95–100	85–95	0. 01–0. 5	0. 17–0. 21	7. 8–8. 2	High	
100	95–100	85–95	0. 01–0. 5	0. 00–0. 10	7. 8–8. 3	High	
100	95–100	75–90	0. 1 –0. 7	0. 00–0. 10	7. 8–8. 3	High	
95–100	95–100	80–90	0. 8 –1. 5	0. 17–0. 20	7. 8–8. 2	Moderate	Susceptible to frequent flooding; substratum is stratified gravel; water table at a depth of 3 to 10 feet.
95–100	95–100	80–90	0. 8 –1. 5	0. 15–0. 18	7. 8–8. 2	Moderate	
95–100	80–100	70–90	0. 8 –1. 5	0. 10–0. 15	7. 8–8. 3	Moderate	
30–50	15–35	10–30	1. 0 –2. 0	0. 10–0. 15	6. 6–8. 0	Low	Caliche and substratum, combined are as much as 20 feet thick and contain large amounts of gravel of mixed origin.
---	---	---	---	---	6. 6–8. 0	Low	
---	---	---	---	---	8. 0–8. 2	Low	
95–100	95–100	80–90	1. 0–1. 8	0. 13–0. 18	7. 8–8. 2	Moderate	Water table is below depth of 20 feet.
95–100	95–100	80–90	1. 0–1. 8	0. 13–0. 17	7. 8–8. 2	Moderate	
95–100	90–100	75–85	1. 0–1. 8	0. 12–0. 15	7. 8–8. 2	Moderate	
95–100	80–95	70–90	1. 0–1. 8	0. 12–0. 15	7. 8–8. 2	Moderate	
55–80	50–75	50–60	0. 8–1. 3	0. 10–0. 20	7. 5–8. 0	Moderate	Hard limestone is fractured into huge slabs or blocks.
---	---	---	0. 8–1. 3	0. 10–0. 15	7. 8–8. 2	---	
---	---	---	---	---	8. 2	---	
95–100	95–100	80–90	0. 8–1. 5	0. 17–0. 21	7. 8–8. 2	Moderate	Water table is below depth of 20 feet.
95–100	95–100	75–85	0. 8–1. 5	0. 15–0. 20	7. 8–8. 2	Moderate	
85–100	80–100	70–90	0. 8–1. 5	0. 12–0. 17	7. 8–8. 2	Moderate	

TABLE 4.—*Engineering*

[Tests performed by Texas Highway Department in accordance with standard procedures

Soil name and location	Parent material	Texas report number	Depth	Horizon	Shrinkage		
					Limit	Lineal	Ratio
Knippa silty clay:			*Inches*				
6.8 miles north of Courthouse in Brackettville on Farm Road 674; 800 feet north and 100 feet east of entrance to Alamo Village. (Modal profile)	Alluvium (outwash).	62-6-R 62-7-R	8-19 41-55	A12 Cca	13 12	15. 5 14. 8	1. 91 2. 00
6.8 miles north of Courthouse in Brackettville on Farm Road 674 and 2 miles northeast of Shahan Ranch entrance. (Gravelly subsoil)	Alluvium (outwash).	62-8-R 62-9-R	6-15 25-57	A12 Cca	13 14	15. 8 13. 7	1. 89 1. 89
12 miles northeast of Brackettville; 0.6 mile north of Farm Road 334; 575 feet north and 60 feet west of Tularosa Road. (Heavier clay than in modal profile)	Alluvium (outwash).	62-10-R 62-11-R	7-24 41-56	A12 Cca	11 13	19. 4 15. 4	1. 96 1. 98
Montell clay:							
2 miles south of Spofford on State Route 131 and 100 feet northeast of Farm Road 1908. (Modal profile)	Old alluvium.	62-14-R 62-15-R	10-30 43-56	A12 Cca [5]	10 13	17. 8 16. 1	2. 03 1. 94
2 miles west of Brackettville on U.S. Highway No. 90 and 3 miles southwest on Farm Road 693; 60 feet east of road. (Less clayey than in modal profile)	Old alluvium.	62-12-R 62-13-R	10-30 43-64	A12 Cca [5]	13 10	20. 2 19. 8	2. 00 2. 01
7 miles south of Spofford and 800 feet north of county line; 100 feet northeast of State Route 131. (More clayey than in modal profile)	Old alluvium.	62-16-R 62-17-R	11-24 35-51	A12 Cca [5]	11 13	22. 2 20. 3	2. 03 1. 92
Uvalde silty clay loam:							
2 miles west of Brackettville on U.S. Highway No. 90 and 5 miles southwest on Farm Road 693; 1.2 miles west on lane to Kerr Ranch. (Modal profile)	Old outwash.	62-20-R 62-21-R	6-17 27-38	A12 Cca	13 12	13. 5 12. 6	1. 90 1. 96
2 miles west of Brackettville and 3 miles southwest of U.S. Highway No. 90; 600 feet east of Farm Road 693. (More clayey than in modal profile)	Old outwash.	62-18-R 62-19-R	9-23 36-49	A12 Cca	11 14	15. 6 12. 9	1. 92 1. 85
7 miles east of Spofford and 0.55 mile north of Farm Road 1572; 30 feet west of lane to Franks Ranch. (Thicker Cca horizon than in modal profile)	Old outwash.	62-22-R 62-23-R	5-14 29-58	A12 Cca	15 15	10. 2 9. 2	1. 85 1. 87

[1] Mechanical analyses according to the AASHO Designation T 88-57 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes for soils.

test data

of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [1]										Liquid limit	Plasticity index	Classification	
Percentage passing sieve—							Percentage smaller than—					AASHO [2]	Unified [3]
2 in.	¾ in.	⅜ in.	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.				
------	100	100	99	99	92	89	85	60	48	48	27	A–7–6(16)	CL.
100	98	95	91	84	77	73	71	50	40	43	25	A–7–6(14)	CL.
100	96	94	91	87	81	77	73	49	38	49	28	A–7–6(17)	CL.
[4] 100	76	61	49	37	33	31	31	23	16	43	24	A–2–7(2)	SC.
------	100	99	97	94	81	78	75	58	43	57	34	A–7–6(19)	CH.
100	98	94	91	88	83	80	80	58	42	46	28	A–7–6(16)	CL.
------	------	------	------	100	96	87	82	65	55	49	31	A–7–6(18)	CL.
------	------	------	100	99	92	84	80	56	31	49	31	A–7–6(18)	CL.
------	------	------	100	99	95	89	86	70	60	62	40	A–7–6(20)	CH.
------	------	------	------	100	95	89	85	66	7	56	36	A–7–6(19)	CH.
------	------	------	100	99	99	91	89	67	58	67	41	A–7–6(20)	CH.
------	------	------	100	98	88	78	77	58	13	64	41	A–7–6(20)	CH.
------	------	------	100	99	93	81	75	50	40	41	23	A–7–6(13)	CL.
------	------	------	------	100	96	88	83	56	38	38	20	A–6(12)	CL.
100	99	99	99	99	91	84	78	57	45	46	25	A–7–6(15)	CL.
------	------	------	100	99	94	89	89	67	55	42	22	A–7–6(13)	CL.
------	100	100	99	97	90	80	76	52	35	35	18	A–6(11)	CL.
100	96	91	86	80	77	72	70	51	34	33	16	A–6(10)	CL.

[2] Based on AASHO Designation M 145–49 (*1*).
[3] Based on Unified Soil Classification System, Tech. Memo. No. 3–357, v. 1, Corps of Engineers, March 1953 (*9*).
[4] Based on sample as received in laboratory. Laboratory test data not corrected for the 3- to 10-inch material, amounting to 20 percent discarded in field sampling.
[5] Cca horizon contains gypsum, but laboratory test data were not corrected.

TABLE 5.—*Engineering*

Soil	Suitability of soil for—			Limitations to disposal of sewage effluent	Soil features affecting—		
	Road subgrade	Road fill	Topsoil		Highway location	Farm ponds: Reservoir area	Farm ponds: Embankment
Alluvial land (Al)	Fair	Fair	Poor	Severe	Susceptibility to flooding.	Rapid permeability.	Fair stability; rapid permeability.
Dev soils (Ds)	Poor	Fair	Poor	Severe	Susceptibility to flooding; gravelly and stony material.	Very gravelly material; rapid permeability.	Poorly graded material.
Ector-Rock outcrop complex (Et).	Fair	Fair	Poor	Severe	Limestone bedrock near surface; stony material; steep slopes.	Very stony material; very shallow over limestone.	Very stony material;[1] very shallow over hard limestone.
Ector soils (Ec)	Good	Good	Poor	Severe	Limestone bedrock near surface; stony soil; steep slopes.	Very stony material; very shallow over hard limestone.	Very stony material; very shallow over hard limestone.
Frio clay loam (Fr)	Fair	Fair	Good	Slight	Susceptibility to flooding.	Moderate permeability; excessive seepage.	Fair stability
Gila loam (Gm)	Fair	Fair	Fair	Slight	No unfavorable features.	Rapid permeability.	Rapid permeability; fair stability.
Glendale clay loam (Gc).	Poor to fair.	Fair	Good	Slight	No unfavorable features.	Moderate permeability.	Fair stability; moderate permeability.
Ingram stony clay (In).	Poor to fair.	Poor to fair.	Poor	Severe	Steep slopes; stoniness; high shrink-swell potential; hard bedrock.	Shallow over hard limestone; very stony over basalt.	High shrink-swell potential; very stony material.
Kavett-Tarrant stony clays (Kc).	Poor	Fair	Poor	Severe	Stoniness; hard limestone near surface.	Shallow over hard limestone.	Fair stability
Kimbrough-Ector association (Ke).	Good	Good	Poor	Severe	Very shallow over caliche or limestone.	Very shallow over caliche or limestone.	Good stability; moderate permeability.
Kimbrough soils (Kh)	Good	Good	Poor	Severe	Very shallow over caliche.	Very shallow over caliche; moderate permeability.	Good stability; moderate permeability.
Jimenez-Zapata association (Jm).	Good	Good	Poor	Severe	Very shallow over caliche; steep slopes; very gravelly material.	Moderate permeability; excessive seepage.	Poorly graded material; moderate permeability.

See footnotes at end of table.

interpretations of the soils

Soil features affecting—Continued						
Irrigation		Land leveling	Field and diversion terraces	Waterways	Remarks
Sprinkler system	Surface system				
Rapid permeability; moderate water-holding capacity; susceptibility to flooding; saline spots.	Rapid permeability; susceptibility to flooding.	Susceptibility to flooding.	Low flood plain; susceptibility to flooding.	Susceptibility to flooding.	
Gravelly and stony material; susceptibility to flooding.	Susceptibility to flooding; very gravelly and stony material.	Gravelly and stony material; susceptibility to flooding.	Gravelly and stony material; susceptibility to flooding.	Susceptibility to flooding; stony material.	
Stony material; very shallow over hard limestone.	Stony material; very shallow over hard limestone; steep slopes.	Very shallow over hard limestone; stony soil; steep slopes.	Very shallow over hard limestone; steep slopes.	Very shallow over hard limestone.	Source of limestone; possible source of rock asphalt at a depth in rock stratum.
Stony material; very shallow over hard limestone.	Stony material; very shallow over hard limestone; steep slopes.	Very shallow over hard limestone; stony material; steep slopes.	Very shallow over hard limestone; steep slopes; hard limestone bedrock.	Very shallow over hard limestone.	Source of limestone.
Moderate permeability; high water-holding capacity.	Rapid intake rate; requires light application of water.	No unfavorable features.	No unfavorable features.	Slightly susceptible to erosion.	
Rapid permeability; moderately good water-holding capacity.	Rapid rate of intake; requires light application of water.	No unfavorable features.	No unfavorable features.	No unfavorable features.	
Fair intake rate and water-holding capacity.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	
Slow intake rate; fair water-holding capacity.	Steep slopes	Steep slopes; shallow soil; stoniness.	Stoniness; steep slopes.	Stoniness	Possible source of traprock.
Slow permeability	Slow permeability	Shallow over hard limestone; stoniness; steep slopes.	Stoniness; shallow over hard limestone.	Stoniness; shallow over hard limestone.	Source of limestone.
Very shallow over caliche or limestone; low water-holding capacity.	Very shallow over caliche or limestone; gravelly material; low water-holding capacity.	Very shallow over caliche or limestone.	Very shallow over caliche or limestone.	Very shallow over caliche or limestone.	Possible source of limestone chalk or caliche.
Very shallow over caliche; gravelly material.	Very shallow over caliche; gravelly material; low water-holding capacity.	Very shallow over caliche.	Very shallow over caliche.	Very shallow over caliche.	Source of caliche.
Very shallow over caliche; very gravelly material; steep slopes.	Very shallow over caliche; very gravelly material; steep slopes.	Very shallow over caliche; steep slopes.	Very shallow over caliche; very gravelly material; steep slopes.	Very shallow over caliche; gravelly material; steep.	Source of caliche and gravel.

TABLE 5.—*Engineering interpretations*

Soil	Suitability of soil for—			Limitations to disposal of sewage effluent	Soil features affecting—		
	Road subgrade	Road fill	Topsoil		Highway location	Farm ponds	
						Reservoir area	Embankment
Knippa silty clay (Kn)	Poor	Poor	Fair	Severe	High shrink-swell potential.	Slow permeability	High plasticity; fair stability.
Limestone rockland (Lr).	Poor	Poor	Not suitable.	Severe	Steep slopes; stony rockland.	Hard limestone	Hard limestone [1]
Montell clay (Mc)	Poor	Poor	Fair	Severe	High shrink-swell potential.	No unfavorable features.	High plasticity; excessive cracking.
Montell clay, low (Mo)	Poor	Poor	Poor	Severe	High shrink-swell potential.	Very slow permeability.	Very high plasticity; excessive cracking.
Pintas silty clay loam (Pc).	Poor to fair.	Fair	Good	Severe	Susceptibility to flooding.	Excessive seepage; gravel in substratum.	Fair stability
Quemado soils (Qu)	Good	Good	Poor	Severe	Very gravelly material; shallow over caliche.	Moderate permeability; excessive seepage.	Poorly graded material; moderate permeability.
Reagan loam (Ra)	Fair to poor.	Fair	Fair	Slight	No unfavorable features.	Moderate permeability.	Fair stability
Tarrant-Rock outcrop complex (Tr). Tarrant soils (Ts).	Poor	Fair	Poor	Severe	Limestone bedrock near surface; steep slopes; stoniness.	Very shallow over hard limestone.	Very shallow over hard limestone.[1]
Uvalde silty clay loam (Uv).	Poor to fair.	Fair	Good	Slight	No unfavorable features.	Moderate permeability.	Fair stability

[1] Small rubble masonry or concrete dams may be installed on limestone base.

of the soils—Continued

Soil features affecting—Continued					Remarks
Irrigation		Land leveling	Field and diversion terraces	Waterways	
Sprinkler system	Surface system				
Slow permeability; high water-holding capacity.	Fine-textured material; slow permeability; high water-holding capacity.	No unfavorable features.	No unfavorable features.	No unfavorable features.	
Steep slopes; stony rockland.	Steep slopes; stony rockland.	Steep slopes; stony rockland.	Steep slopes; stony rockland.	Steep, stony rockland.	Source of limestone.
Very slow permeability.	Slow permeability; high water-holding capacity; few saline spots.	No unfavorable features.	No unfavorable features.	No unfavorable features.	
Very slow permeability; susceptibility to flooding.	Very slow permeability; susceptibility to flooding.	Susceptibility to flooding.	Highly plastic material; undrained depressions.	No unfavorable features.	
Moderate intake rate and water-holding capacity.	Rapid intake rate; requires light application of water; susceptibility to frequent flooding.	Susceptibility to frequent flooding.	Susceptibility to frequent flooding.	Susceptibility to frequent flooding.	Fluctuating water table.
Moderate permeability; shallow over caliche; gravelly material; steep slopes; low water-holding capacity.	Moderate permeability; shallow over caliche; steep slopes	Shallow over caliche; gravelly material.	Shallow over caliche; gravelly material; steep slopes.	Shallow over caliche; gravelly material; steep slopes.	Source of well-graded gravel and caliche.
Moderate permeability; moderate depth and water-holding capacity.	Moderate permeability and water-holding capacity.	Shallow to caliche. .	No unfavorable features.	No unfavorable features.	Source of limestone chalk.
Very shallow over hard limestone.	Very shallow over hard limestone; stony material; steep slopes.	Very shallow over hard limestone; stony material; steep slopes.	Very shallow over hard limestone; stony material; steep slopes.	Very shallow over hard limestone; steep slopes.	Source of limestone.
Moderate permeability; high water-holding capacity.	Moderate permeability; high water-holding capacity.	No unfavorable features.	No unfavorable features.	No unfavorable features.	

TABLE 6.—*Soil series classified according to current and old systems of classification*

Series	Current classification			1938 system of classification
	Family	Subgroup	Order	Great soil group
Dev	Loamy skeletal, carbonatic, thermic	Cumulic Haplustolls	Mollisols	Alluvial soils.
Ector	Loamy, carbonatic, thermic	Lithic Haplorthents	Entisols	Lithosols.
Frio	Fine, mixed, thermic	Cumulic Haplustolls	Mollisols	Alluvial soils.
Gila	Coarse silty, mixed, calcareous, thermic	Typic Haplorthents	Entisols	Alluvial soils.
Glendale	Fine silty, mixed, calcareous, thermic	Typic Haplorthents	Entisols	Alluvial soils.
Ingram	Fine, montmorillonitic, thermic	Typic Calciustolls	Mollisols	Grumusols.
Jimenez	Loamy skeletal, mixed, thermic, thin	Mollic Petrocalcic Calciorthids.	Aridisols	Lithosols.
Kavett	Fine, montmorillonitic, thermic	Lithic Calciustolls	Mollisols	Chestnut soils (intergrading toward Lithosols).
Kimbrough	Loamy, mixed, thermic, thin	Petrocalcic Calciustolls	Mollisols	Lithosols.
Knippa	Fine, mixed, thermic	Haplic Calciustolls	Mollisols	Grumusols.
Montell	Thermic	Entic Grumaquerts	Vertisols	Grumusols.
Pintas	Fine, mixed, thermic	Haplic Calciustolls	Mollisols	Calcisols.
Quemado	Loamy skeletal, mixed, thermic	Mollic Petrocalcic Camborthids.	Aridisols	Reddish Brown soils.
Reagan	Fine silty, mixed, thermic	Mollic Calciorthids	Aridisols	Calcisols.
Tarrant	Clayey skeletal, montmorillonitic	Lithic Haplustolls	Mollisols	Lithosols.
Uvalde	Fine, mixed, thermic	Haplic Calciustolls	Mollisols	Calcisols.
Zapata	Loamy, carbonatic, thermic, thin	Petrocalcic Calciorthids	Aridisols	Lithosols.

TABLE 7.—*Precipitation at Brackettville, Texas*

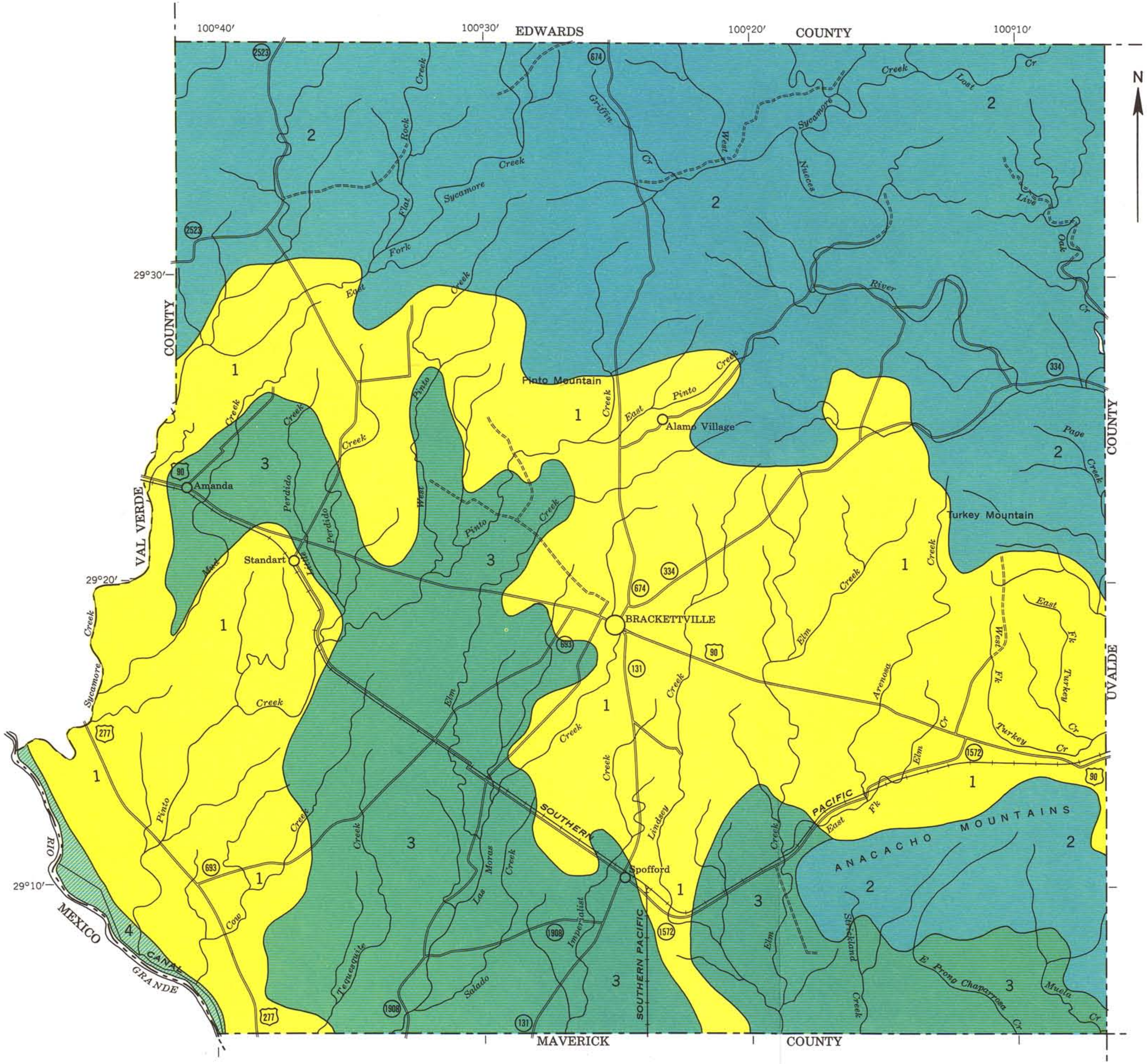
[Elevation, 1,120 feet]

Month	Precipitation [1]			
	Average	Driest year (1956)	Wettest year (1958)	Average snowfall
	Inches	*Inches*	*Inches*	*Inches*
January	0.92	0.17	3.36	0.2
February	1.07	.25	3.28	(2)
March	.89	0	2.66	0
April	1.72	.10	.63	0
May	3.05	.06	3.67	0
June	3.34	0	11.30	0
July	1.87	.40	.35	0
August	1.90	1.09	1.81	0
September	2.62	.17	11.31	0
October	2.04	4.91	6.21	0
November	.72	0	.48	(2)
December	.98	.43	.31	0
Year	21.12	7.58	45.37	.2

[1] Based on a 27-year record, through 1962.
[2] Trace.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
KINNEY COUNTY, TEXAS



Scale 1:253,440

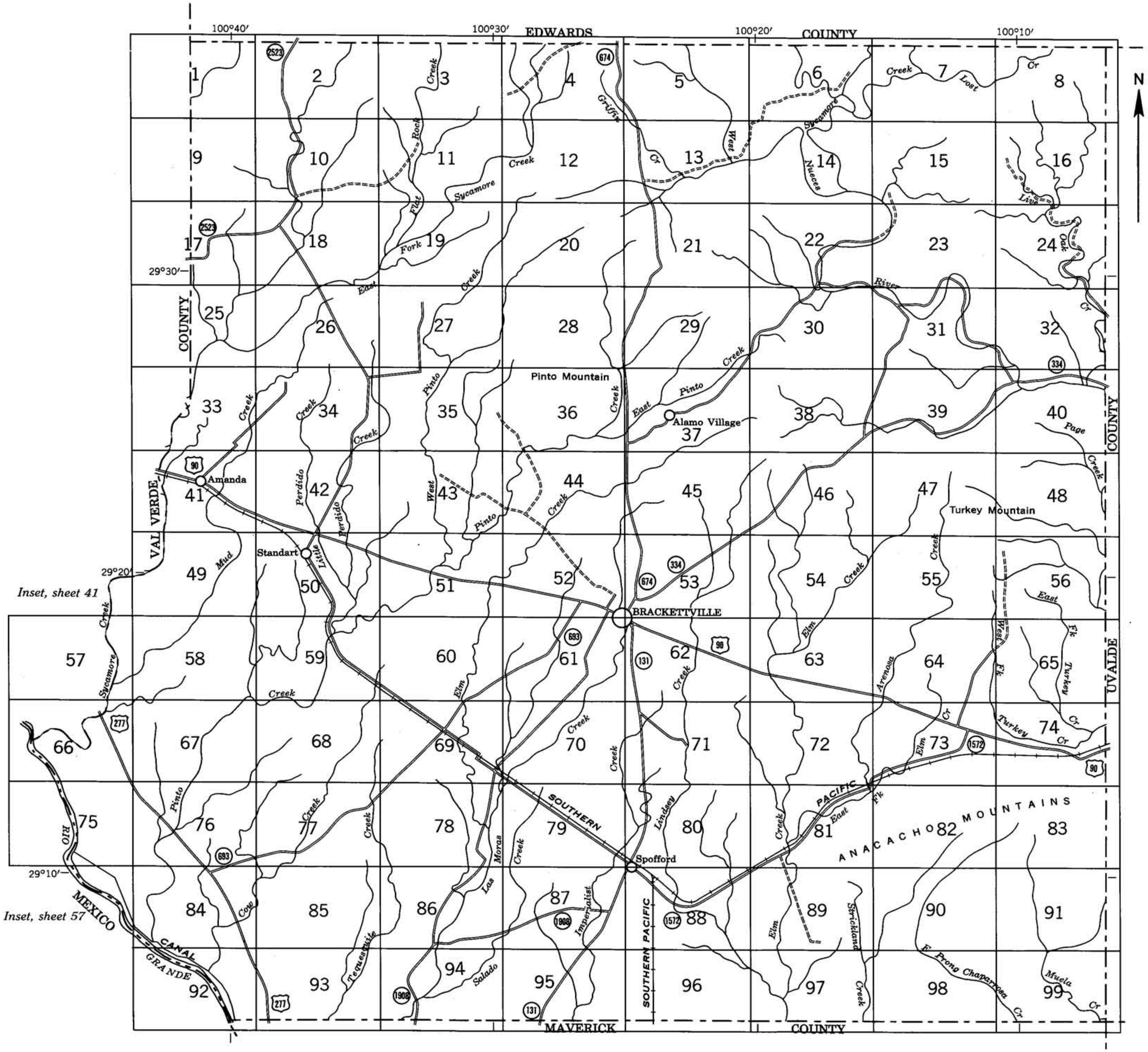
1 0 1 2 3 4 5 Miles

SOIL ASSOCIATIONS

1. Kimbrough-Ector-Uvalde association: Dominantly very shallow, gravelly and stony, loamy soils in nearly level to undulating areas
2. Tarrant-Ector association: Very shallow, stony, clayey and loamy soils in rolling, hilly, and broken areas
3. Uvalde-Montell association: Deep, nearly level, loamy and clayey soils, moderately permeable and slowly permeable
4. Gila-Glendale association: Deep, nearly level, loamy, moderately permeable soils on bottom lands

June 1966

INDEX TO MAP SHEETS
KINNEY COUNTY, TEXAS



Scale 1:253,440

1 0 1 2 3 4 5 Miles

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

KINNEY COUNTY, TEXAS

TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL LEGEND

SYMBOL	NAME
Al	Alluvial land
Ds	Dev soils
Ec	Ector soils
Et	Ector–Rock outcrop complex
Fr	Frio clay loam
Gc	Glendale clay loam
Gm	Gila loam
In	Ingram stony clay
Jm	Jimenez–Zapata association
Kc	Kavett–Tarrant stony clays
Ke	Kimbrough–Ector association
Kh	Kimbrough soils
Kn	Knippa silty clay
Lr	Limestone rockland
Mc	Montell clay
Mo	Montell clay, low
Pc	Pintas silty clay loam
Qu	Quemado soils
Ra	Reagan loam
Tr	Tarrant–Rock outcrop complex
Ts	Tarrant soils
Uv	Uvalde silty clay loam

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church

Windmills

Mines and Quarries

Mine dump

Pits, caliche

Power lines

Pipe lines

Cemeteries

Dams

Levees

Oil or gas wells

Corral

BOUNDARIES

- National or state
- County
- Reservation
- Land grant
- Land division corners

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches — CANAL / DITCH

Lakes and ponds
- Perennial
- Intermittent

Springs

Marsh

Wet spot

Well, irrigation

Well, stock

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

Depressions (Large / Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies

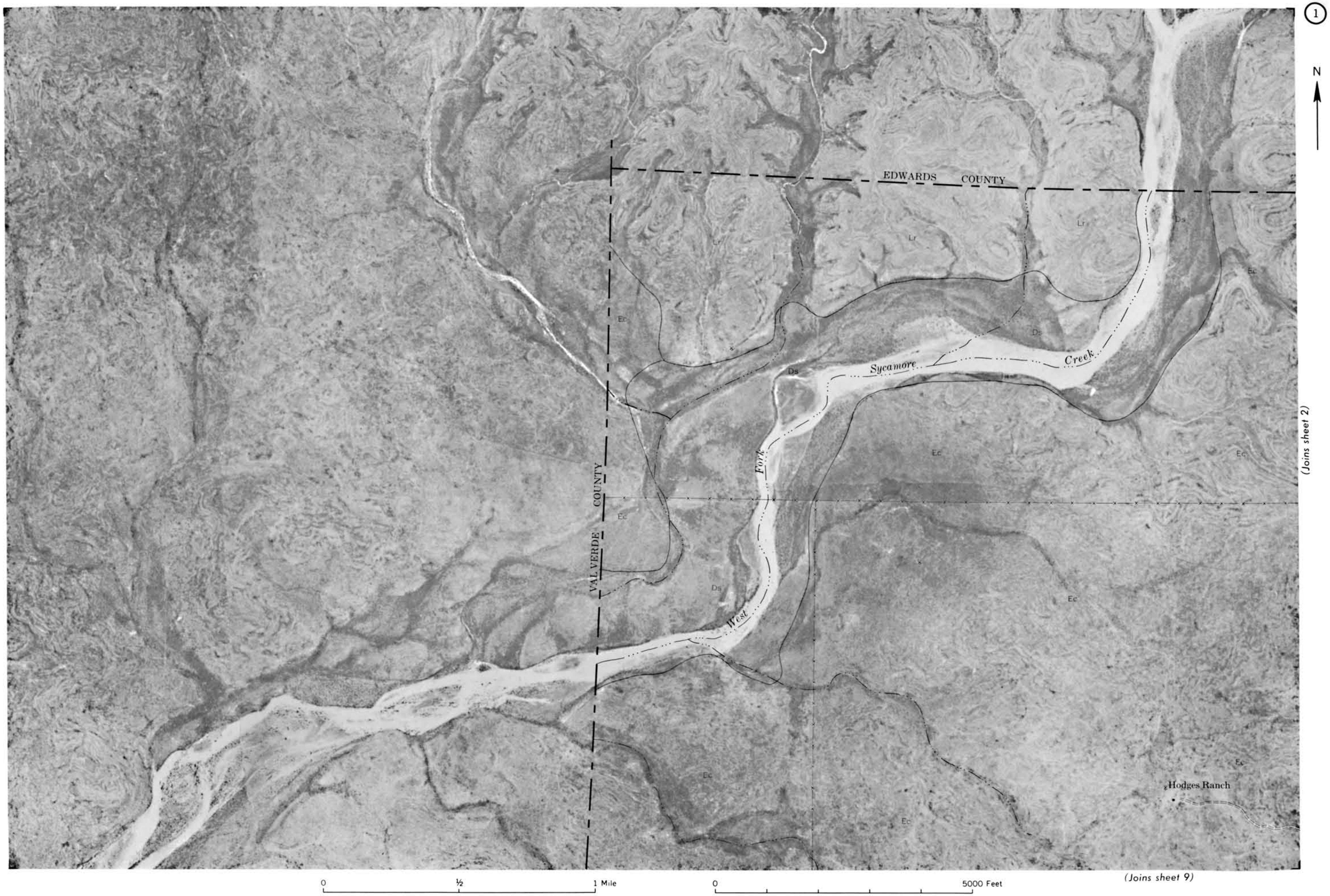
WORKS AND STRUCTURES (CONTINUED)

Forest fire or lookout station

Fence

Note: Fences are shown adjacent to sides of roads and boundaries by v-shaped signs spaced .20 inches apart.

Soil map constructed 1966 by Cartographic Division, Soil Conservation Service, USDA, from 1960 aerial photographs. Controlled mosaic based on Texas plane coordinate system, south central zone, Lambert conformal conic projection, 1927 North American datum.



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


2
N
EDWARDS COUNTY
2523
Kn
Ec
Lr
Ds
Tr
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 10)
0
½
1 Mile
Scale 1:20 000
5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 4

N

(Joins sheet 3)

(Joins sheet 5)

(Joins sheet 12)

0 ½ 1 Mile

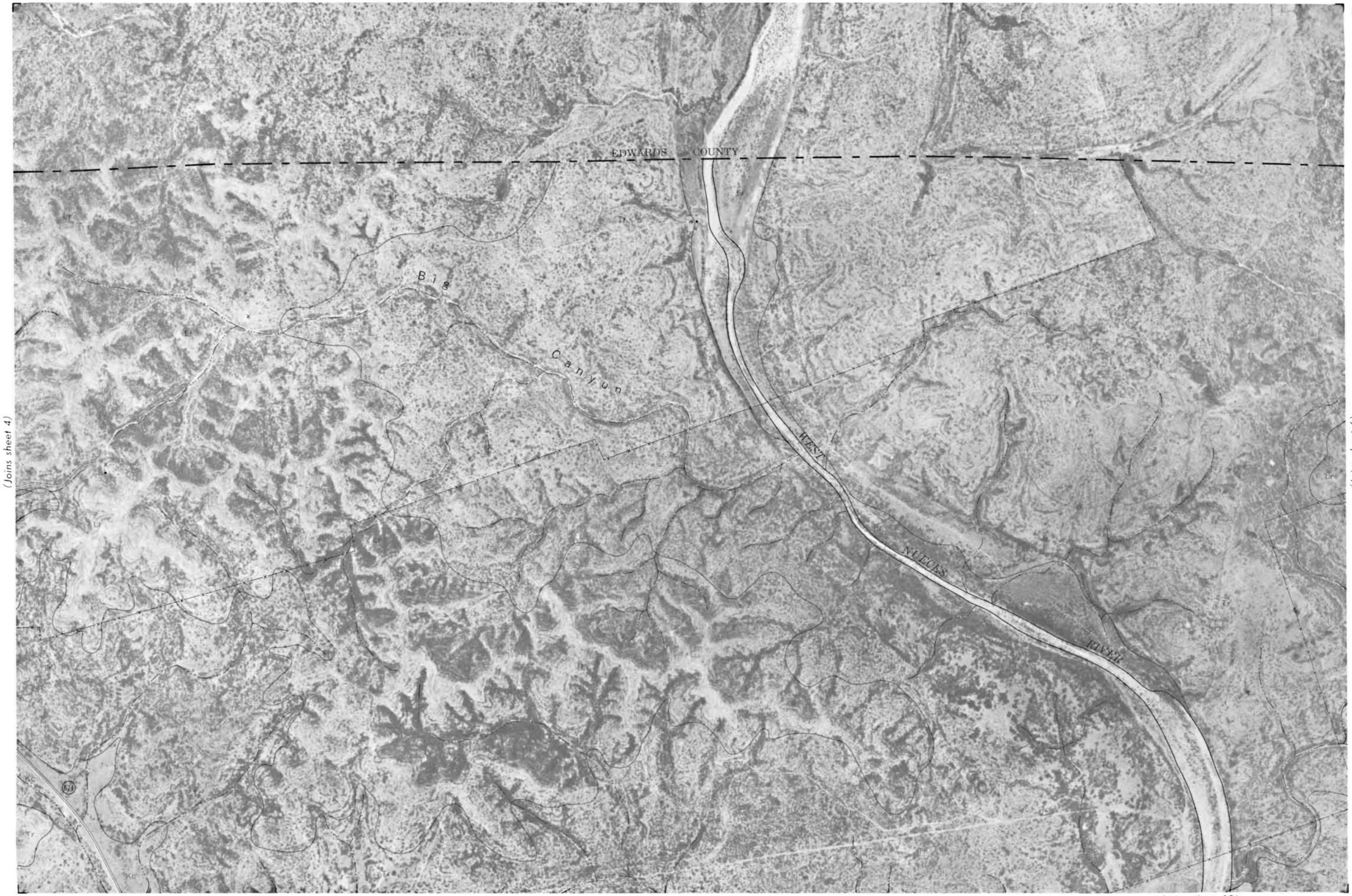
0 5000 Feet

5

N

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(Joins sheet 4)

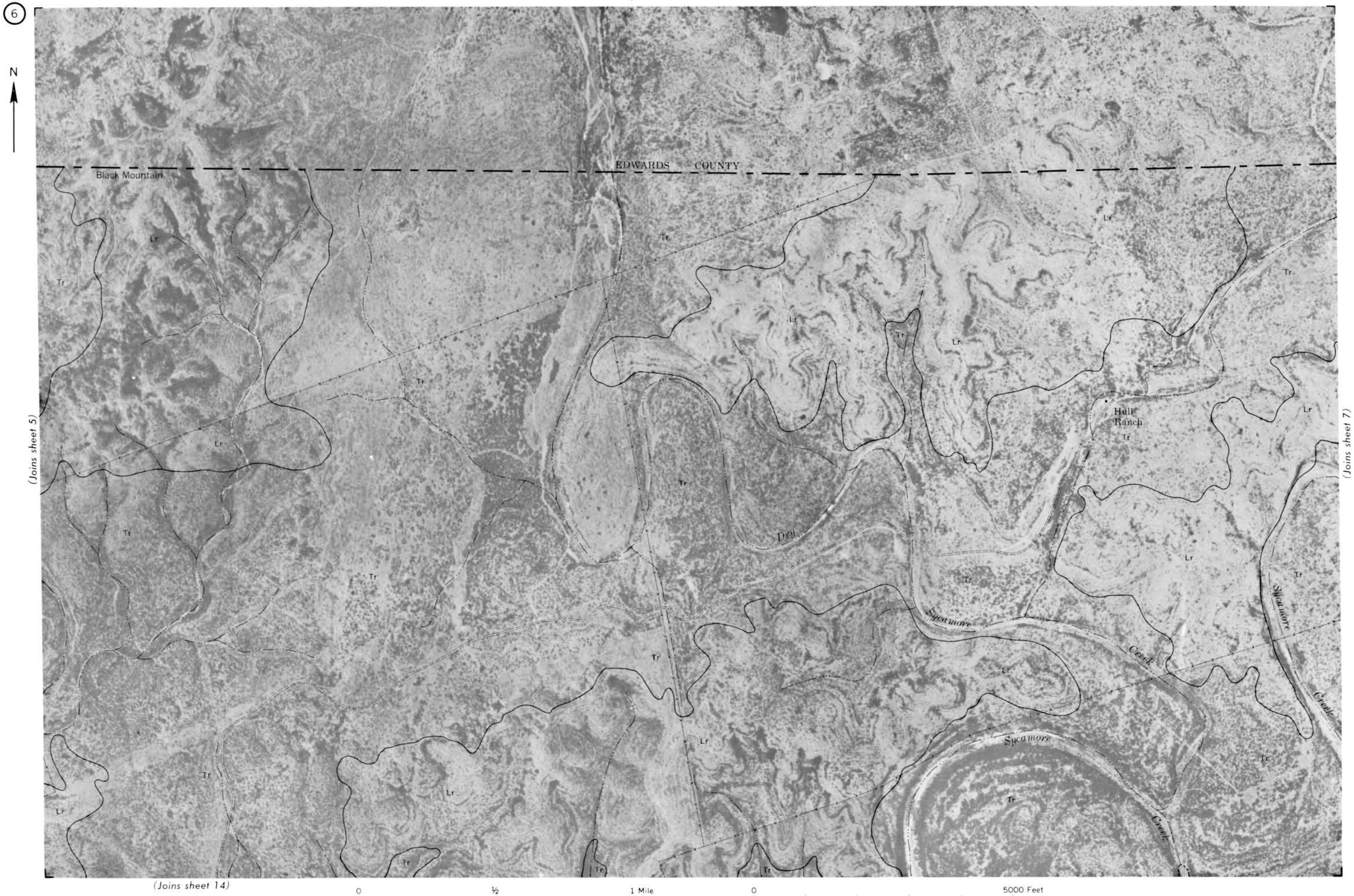


(Joins sheet 6)

(Joins sheet 13)

0 ½ 1 Mile

0 5000 Feet


N
EDWARDS COUNTY
Black Mountain
Hull Ranch
Dry
Sycamore Creek
Sycamore
Creek
Sycamore
Creek
Lr
Tr
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 14)
0
½
1 Mile
0
5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 7

(Joins sheet 6)

(Joins sheet 8)

(Joins sheet 15)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 8

KINNEY COUNTY, TEXAS — SHEET NUMBER 9

0 ½ 1 Mile

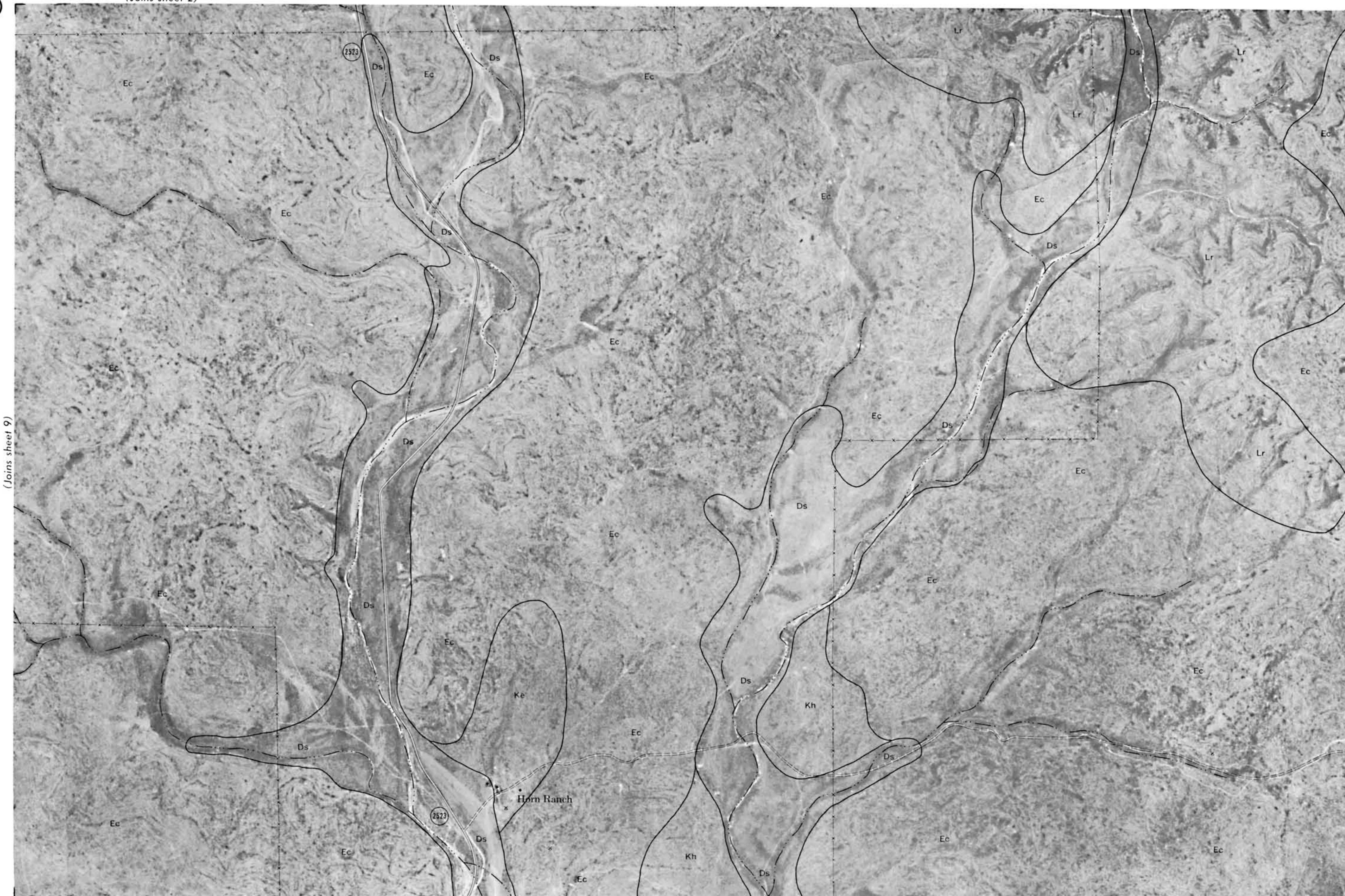
0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 10

(Joins sheet 2)

(Joins sheet 9)



(Joins sheet 11)

(Joins sheet 18)

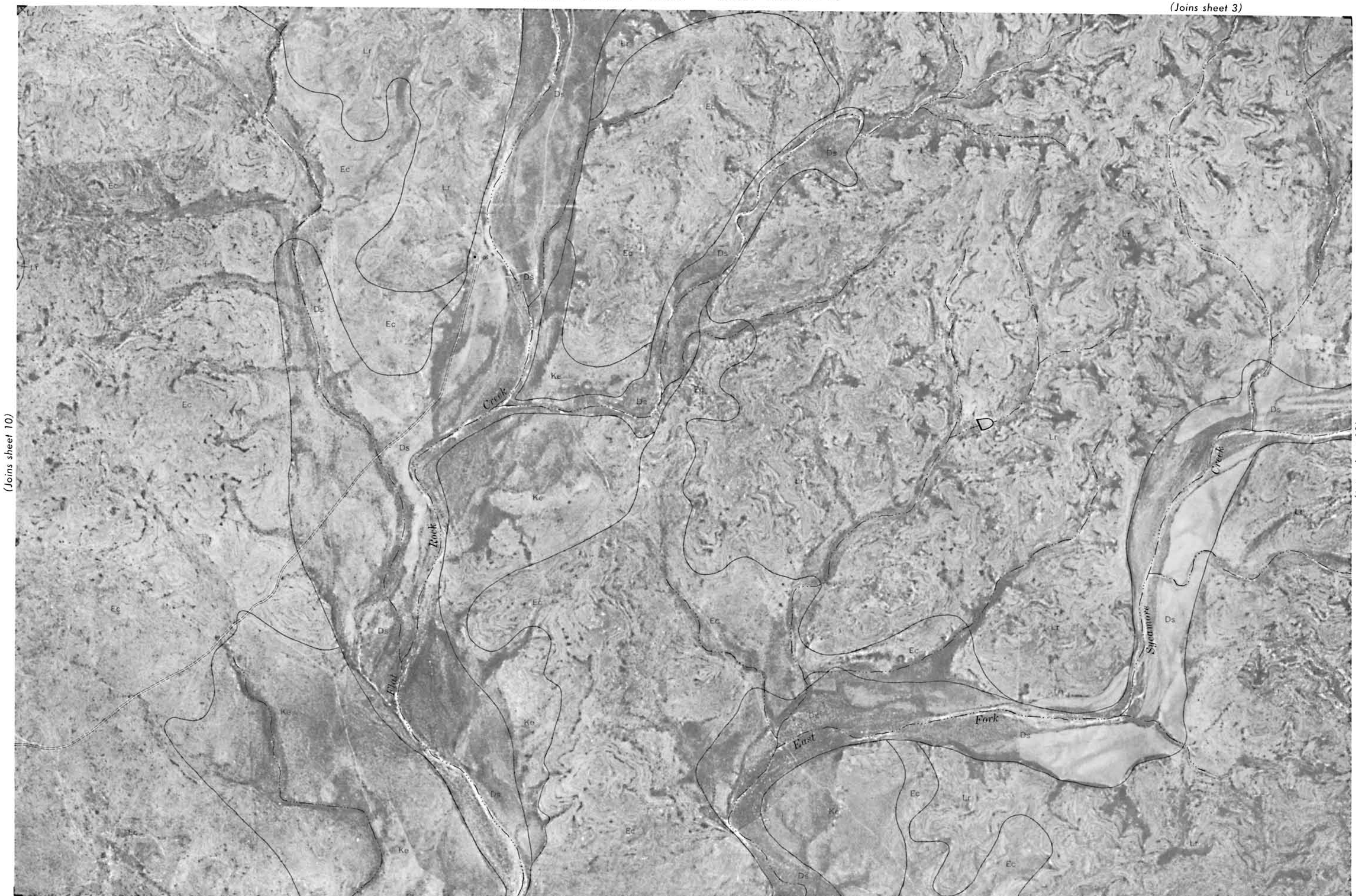
0 ½ 1 Mile

0 5000 Feet

(11)

(Joins sheet 3)

(Joins sheet 10)



(Joins sheet 12)

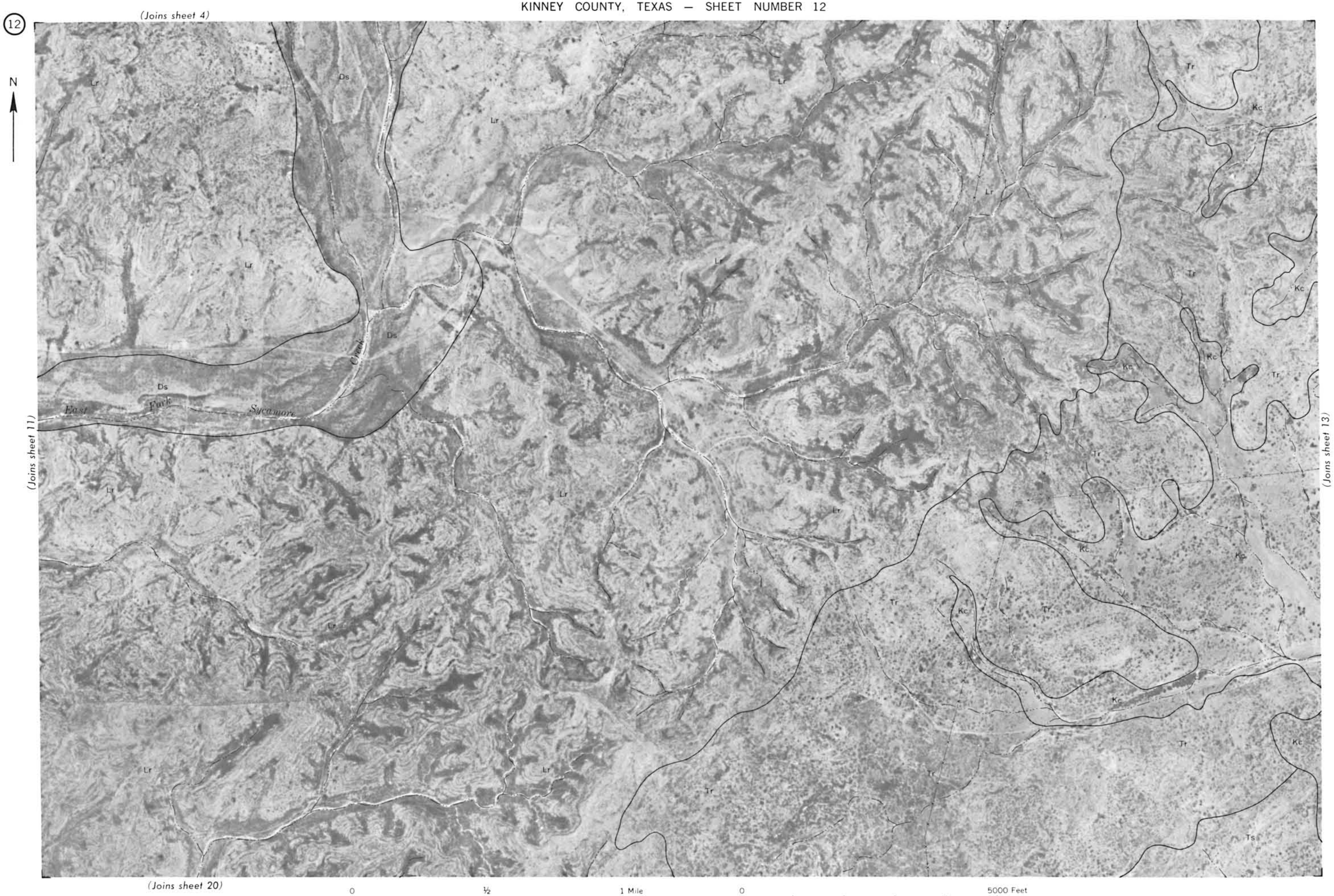
(Joins sheet 19)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

12


(Joins sheet 4)
N
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 20)
East Fork Sycamore Creek
Ds
Lr
Tr
Kc
Ts
0
½
1 Mile
0
5000 Feet

(Joins sheet 5)

13

N

(Joins sheet 12)

(Joins sheet 14)

(Joins sheet 21)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 14

(Joins sheet 6)

(Joins sheet 13)

(Joins sheet 15)

(Joins sheet 22)

(Joins sheet 7)

15

N

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(Joins sheet 14)

(Joins sheet 16)

(Joins sheet 23)

0 ½ 1 Mile

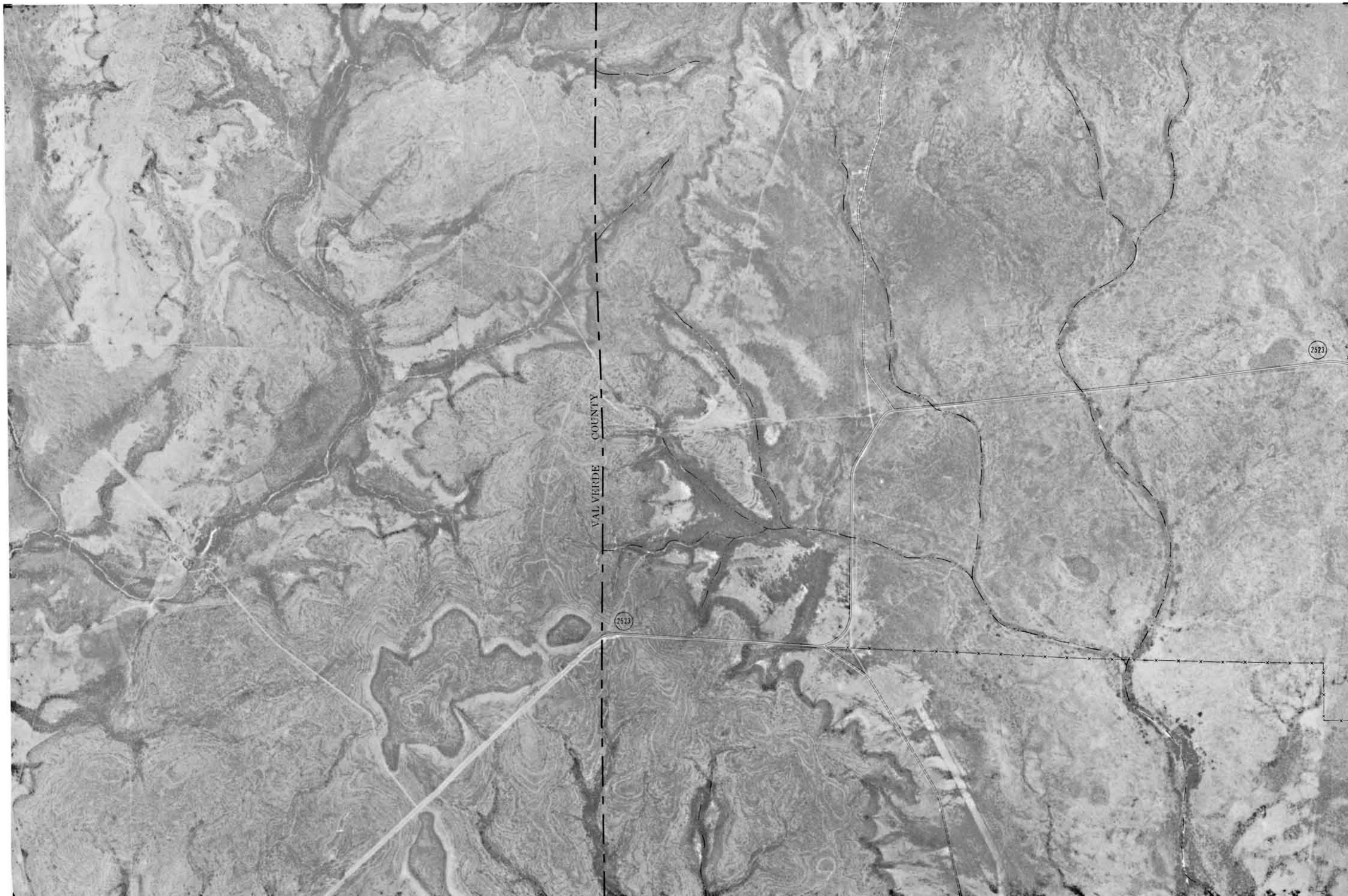
0 5000 Feet


16
(Joins sheet 8)
N
(Joins sheet 15)
(Joins sheet 24)
Frost Ranch
Bull Water Hole Draw
Cherry Draw
Live Oak Creek
UVALDE COUNTY
Lr
Tr
0
½
1 Mile
0
5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 17

(17)

(Joins sheet 9)



(Joins sheet 18)

(Joins sheet 25)

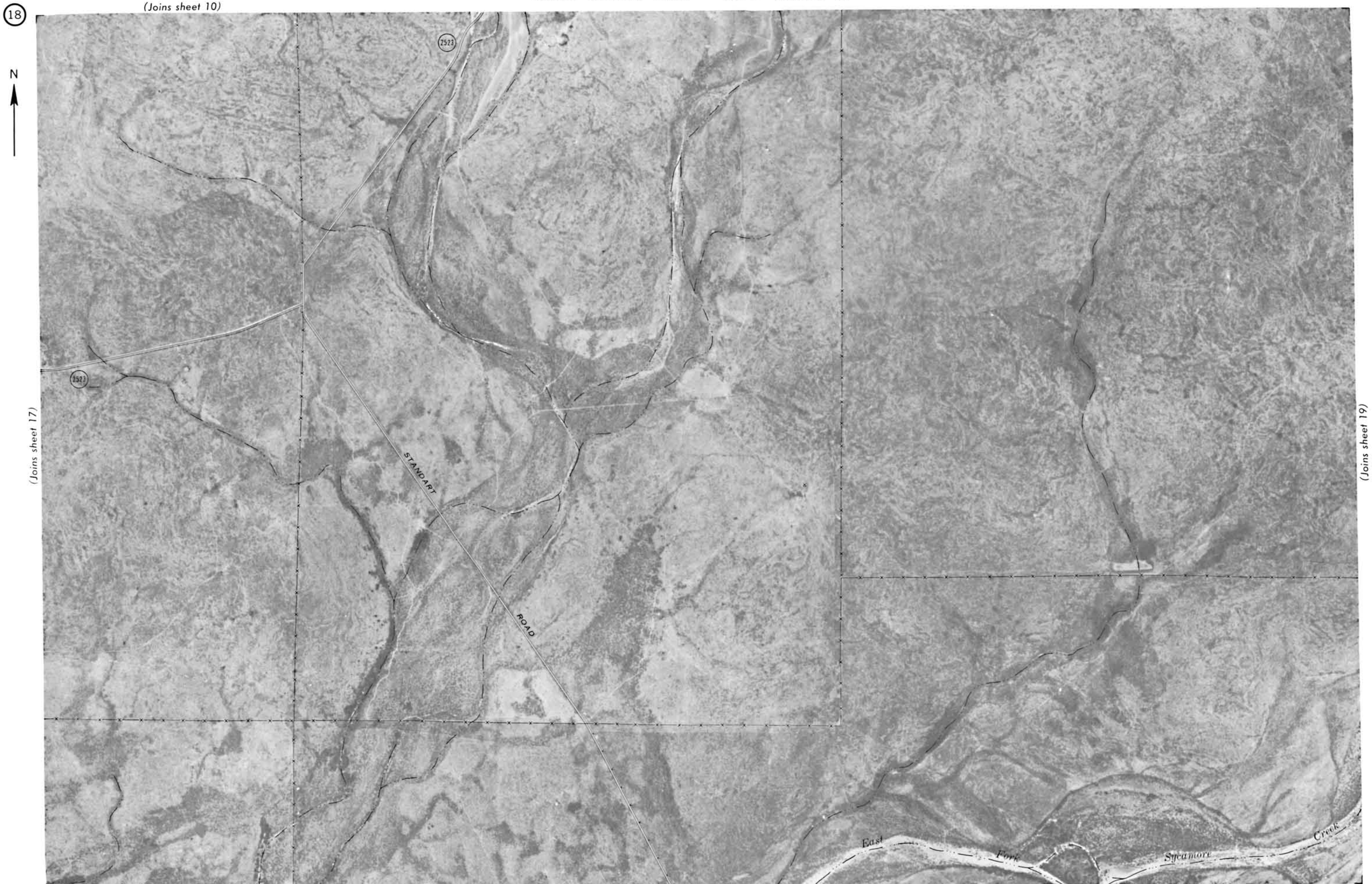
0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 18

(Joins sheet 10)



(Joins sheet 26)

0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 19

(Joins sheet 11)

19

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(Joins sheet 18)

(Joins sheet 20)

(Joins sheet 27)

N

0 ½ 1 Mile

0 5000 Feet

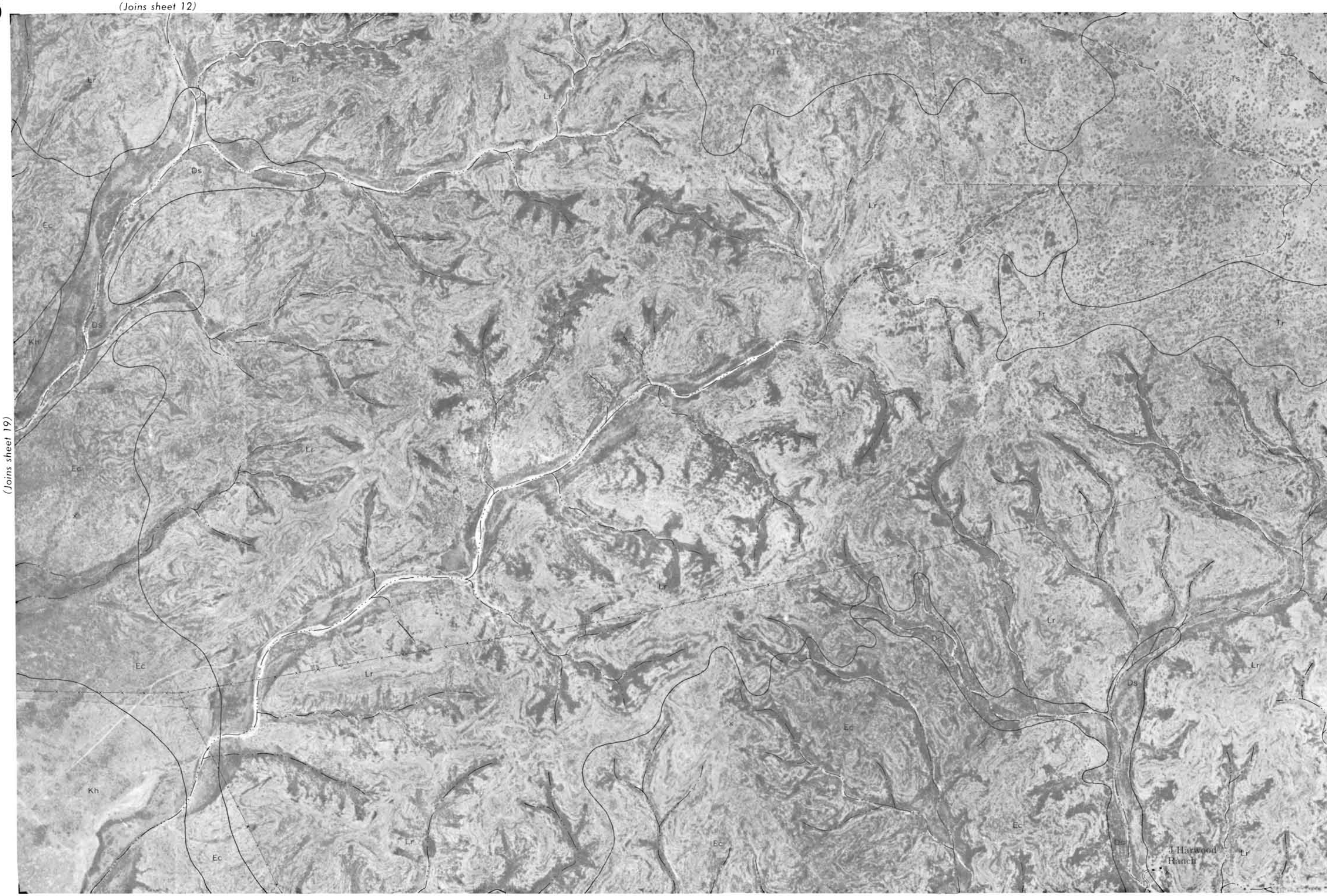
KINNEY COUNTY, TEXAS — SHEET NUMBER 20

20

(Joins sheet 12)

N

(Joins sheet 19)



(Joins sheet 21)

(Joins sheet 28)

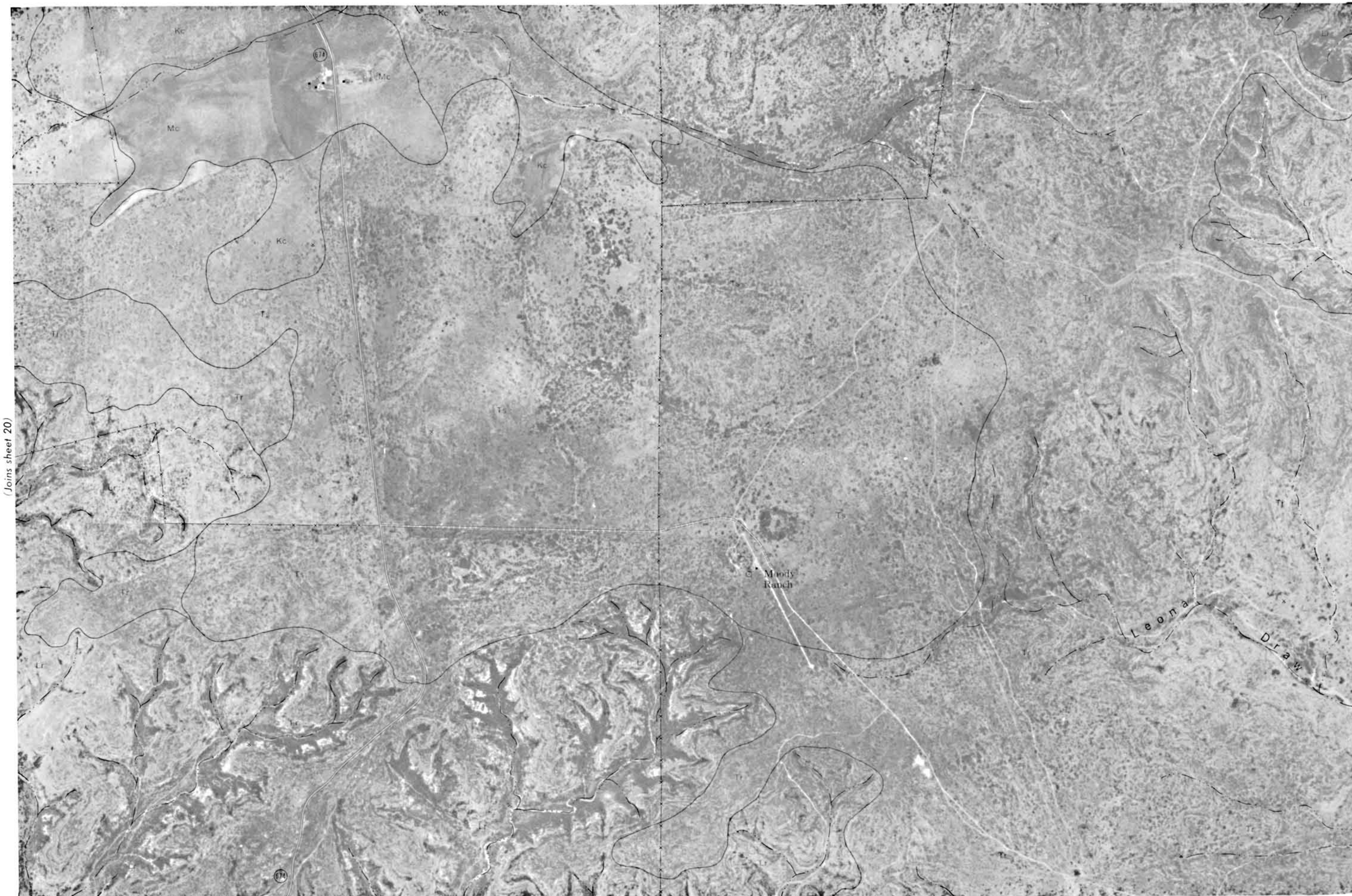
0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 21

(Joins sheet 13)

21



(Joins sheet 20)

(Joins sheet 22)

(Joins sheet 29)

0 ½ 1 Mile

0 5000 Feet

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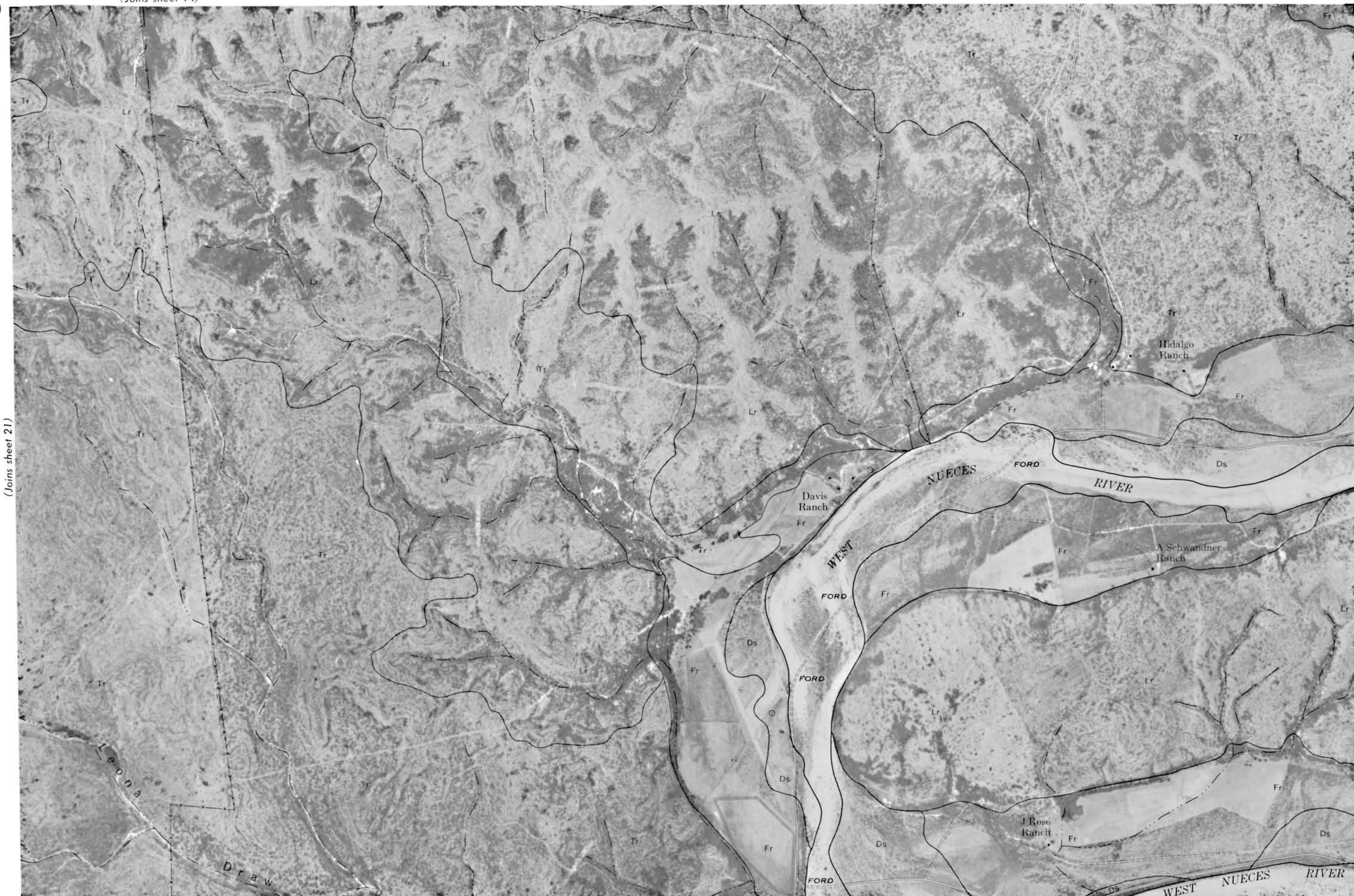
KINNEY COUNTY, TEXAS — SHEET NUMBER 22

(Joins sheet 14)

N



(Joins sheet 21)

(Joins sheet 23)

(Joins sheet 30)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 15)

23

N

(Joins sheet 22)

(Joins sheet 24)

(Joins sheet 31)

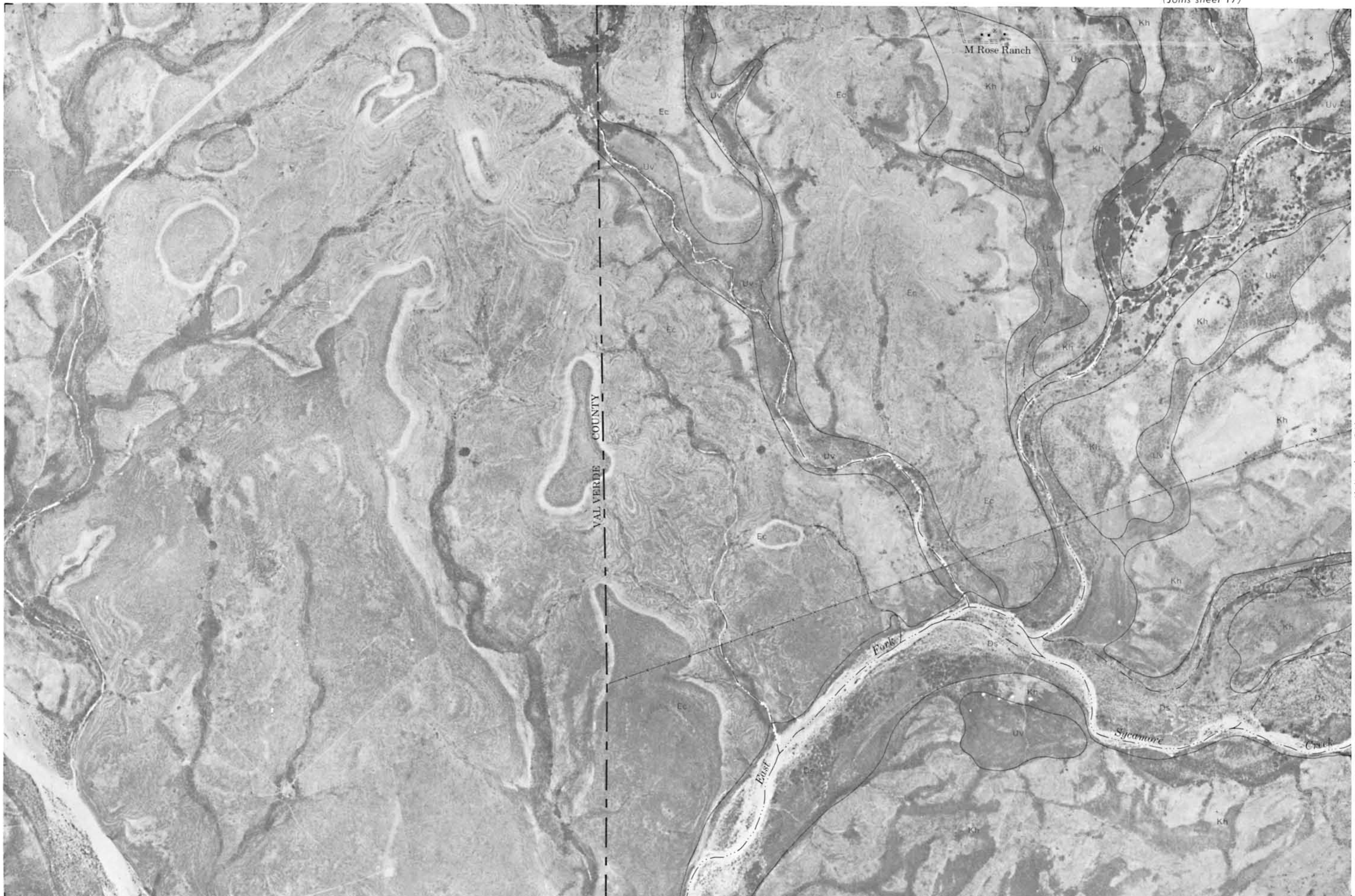
0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


24
(Joins sheet 16)
N
(Joins sheet 23)
(Joins sheet 32)
Dead
Pine
Hollow
Oak
Creek
Boiling
Mountain
UVALDE COUNTY
Smith
Hollow
Negro
Hollow
Chalk
Creek
0
½
1 Mile
0
5000 Feet

(Joins sheet 17)



(Joins sheet 26)

(Joins sheet 33)

0 ½ 1 Mile

0 5000 Feet

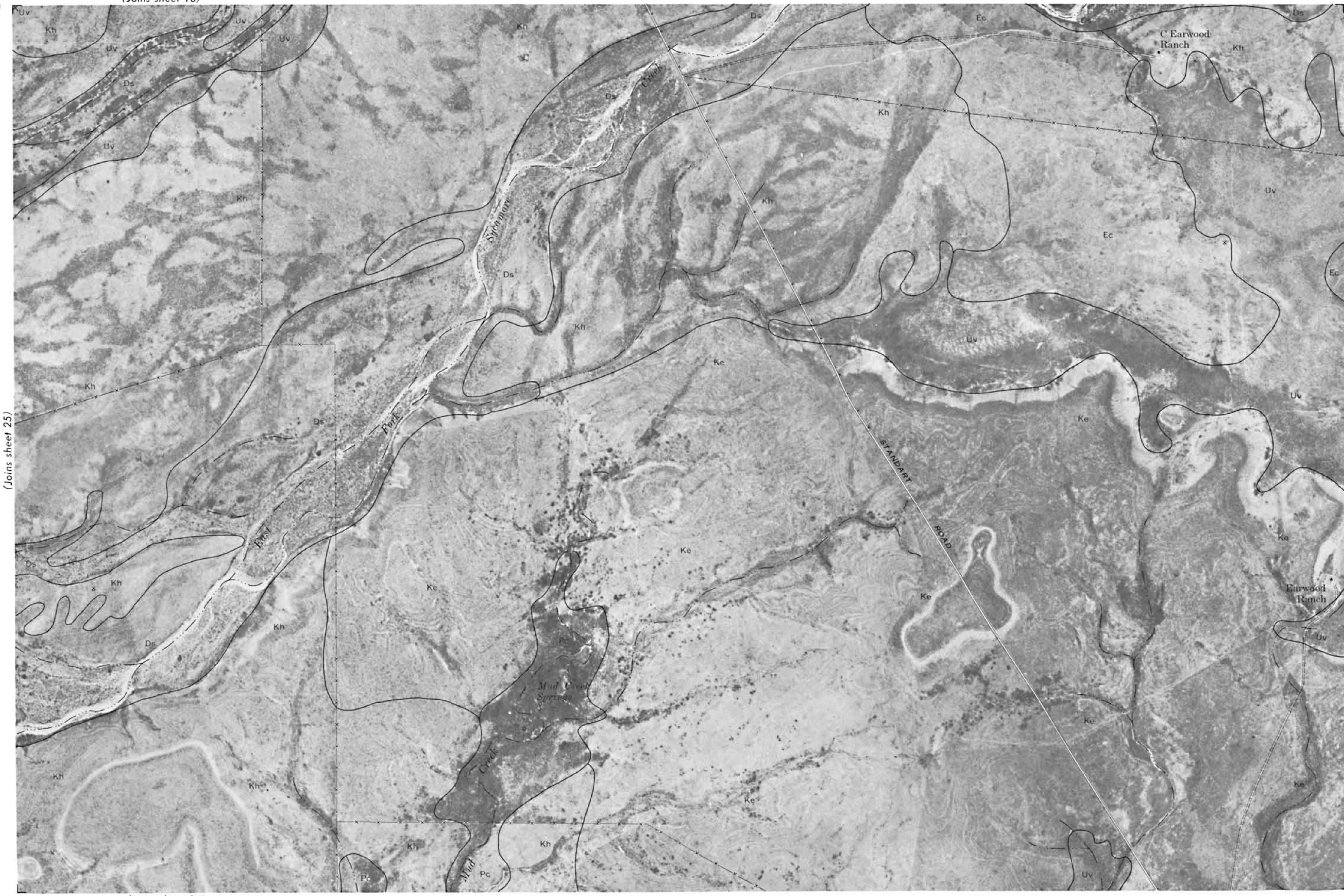
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station

26

N

(Joins sheet 18)

(Joins sheet 25)



(Joins sheet 27)

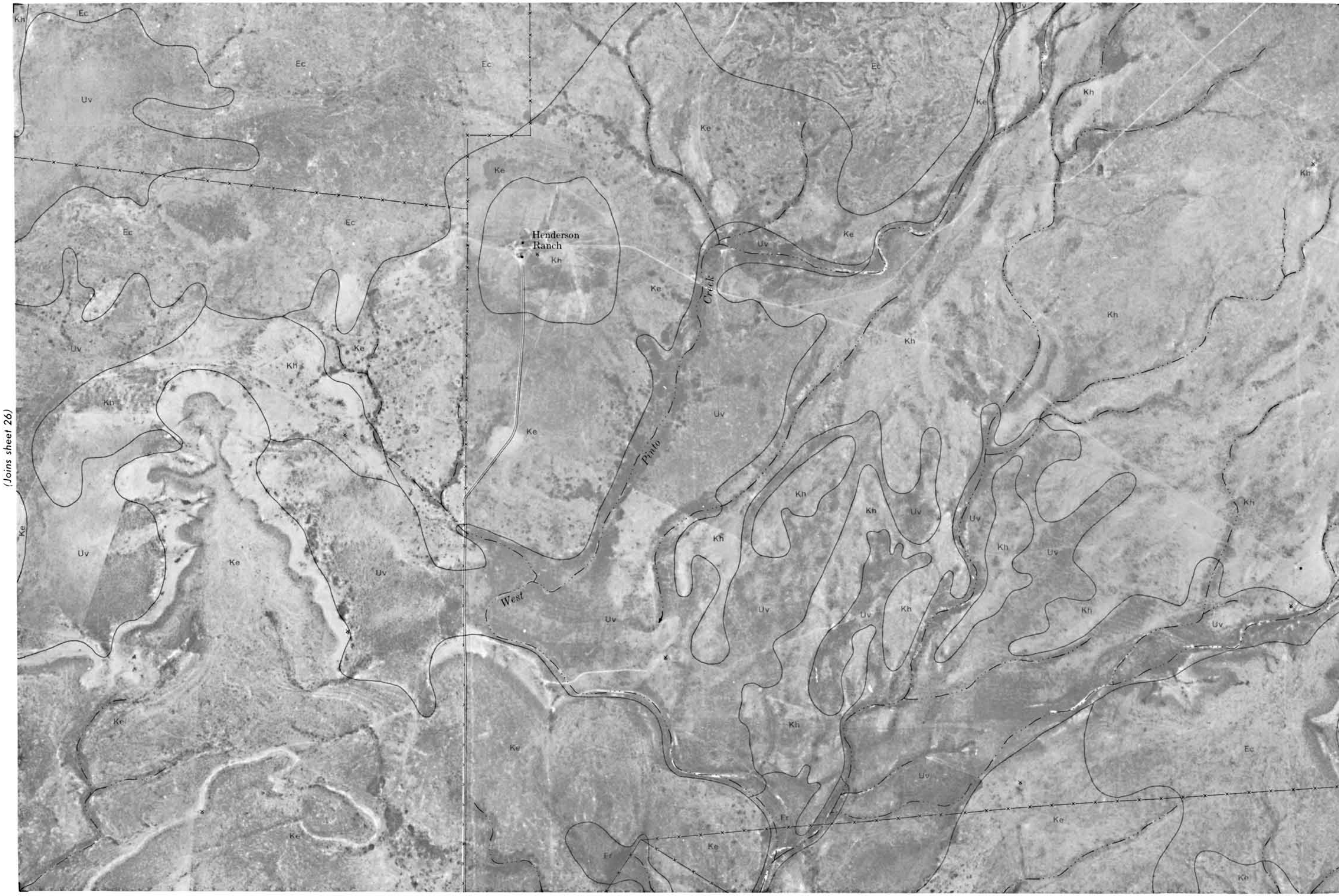
(Joins sheet 34)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 19)

(Joins sheet 26)



N

(Joins sheet 28)

(Joins sheet 35)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

28

KINNEY COUNTY, TEXAS — SHEET NUMBER 28

(Joins sheet 20)

(Joins sheet 27)

(Joins sheet 29)

(Joins sheet 36)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 21)

29

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(Joins sheet 28)

(Joins sheet 30)

(Joins sheet 37)

0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 30

30

(Joins sheet 22)

(Joins sheet 29)

(Joins sheet 31)

(Joins sheet 38)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 32

(Joins sheet 24)

(Joins sheet 31)

(Joins sheet 40)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 25)

33

(Joins sheet 34)

(Joins sheet 41)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(34)

(Joins sheet 26)

(Joins sheet 33)

(Joins sheet 35)

(Joins sheet 42)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 27)

(Joins sheet 34)

(Joins sheet 36)

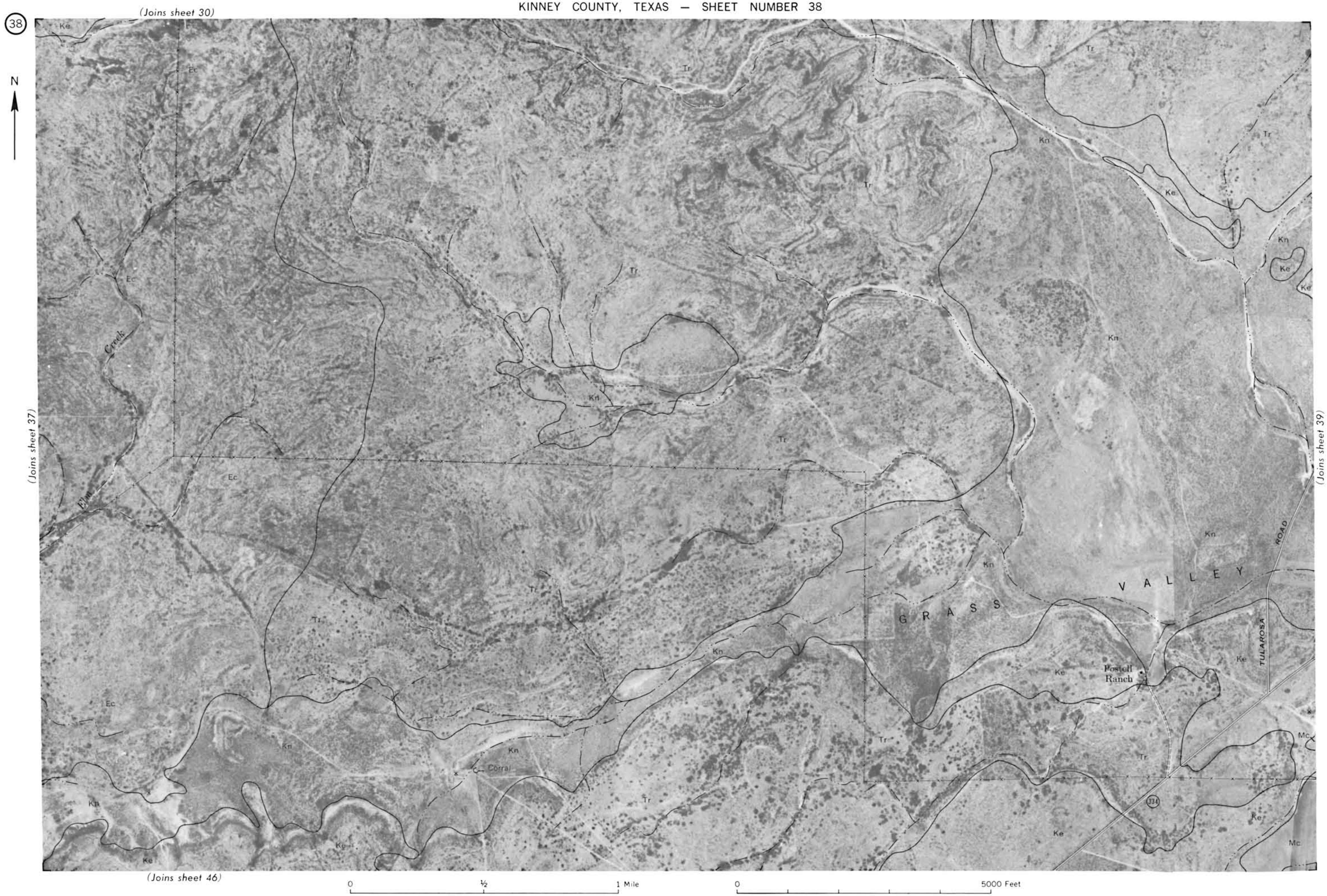
(Joins sheet 43)

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(Joins sheet 28)

(Joins sheet44)

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


38
(Joins sheet 30)
N
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 46)
Elm Creek
GRASS VALLEY
TULAROSA ROAD
Postell Ranch
Corral
334
Ke
Ec
Tr
Kn
Mc
0
½
1 Mile
0
5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 39

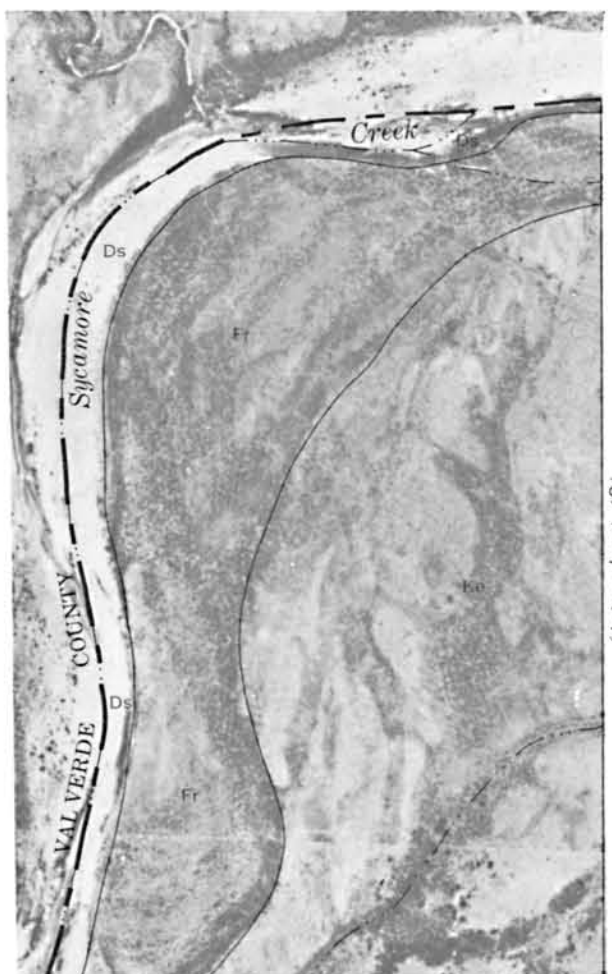
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station


40
(Joins sheet 32)
N
Veltmann Ranch
Corral
Live Oak School (ABANDONED)
Sycamore Cr.
Live Oak Cr.
334
FORD
WEST NUECES RIVER
Dick Hollow
Double Mountain
UVALDE COUNTY
(Joins sheet 39)
Maddux Ranch
Page Creek
Uv
Tr
Ds
Kn
Lr
Fr
(Joins sheet 48)
0
½
1 Mile
0
5000 Feet

(Joins sheet 33)

41

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.



(Joins sheet 49)

(Joins sheet 57)

N

(Joins sheet 42)

(Joins sheet 49)

0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 42

(Joins sheet 34)

(Joins sheet 41)

(Joins sheet 43)

(Joins sheet 50)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 35)

43

(Joins sheet 42)

(Joins sheet 44)

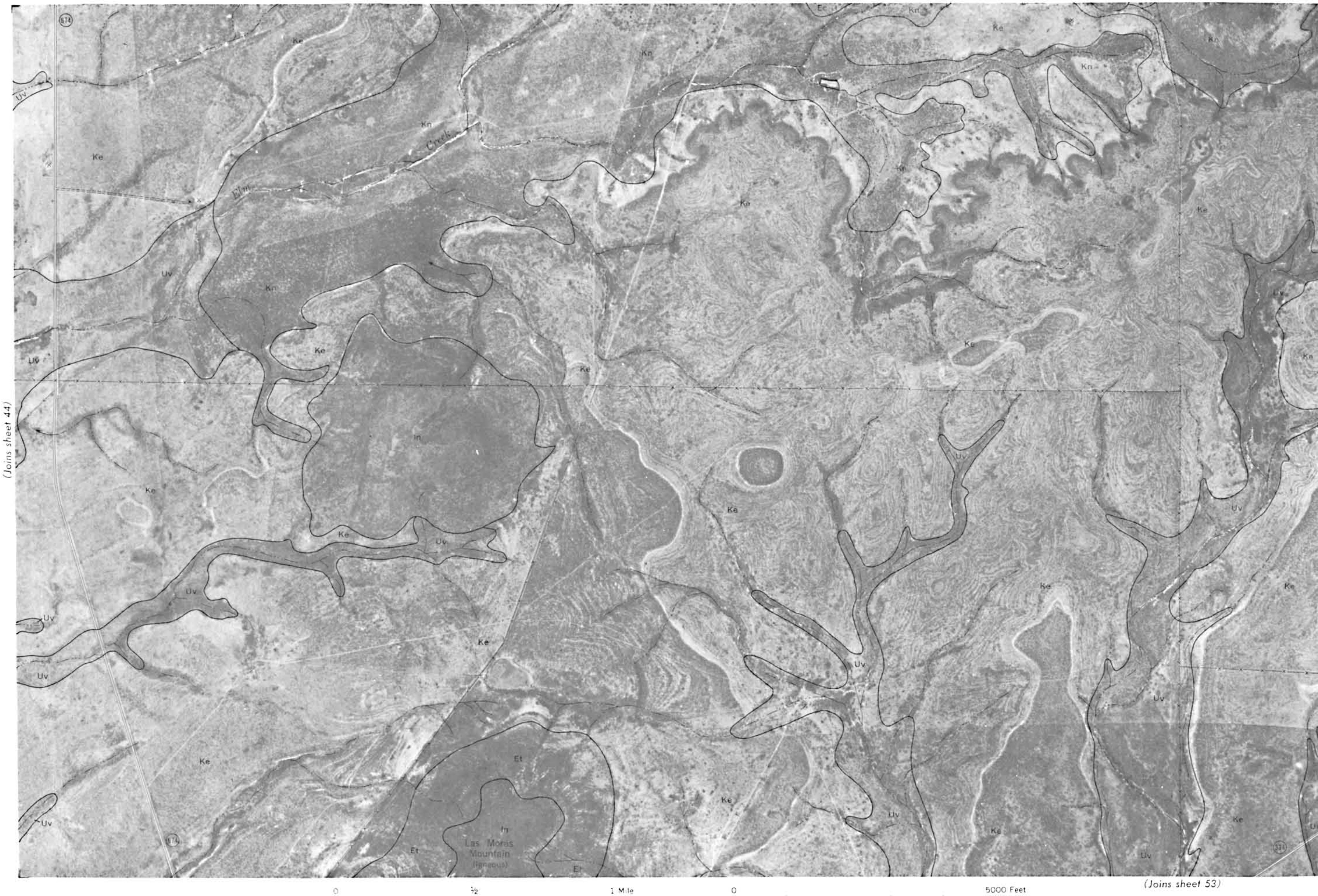
(Joins sheet 51)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

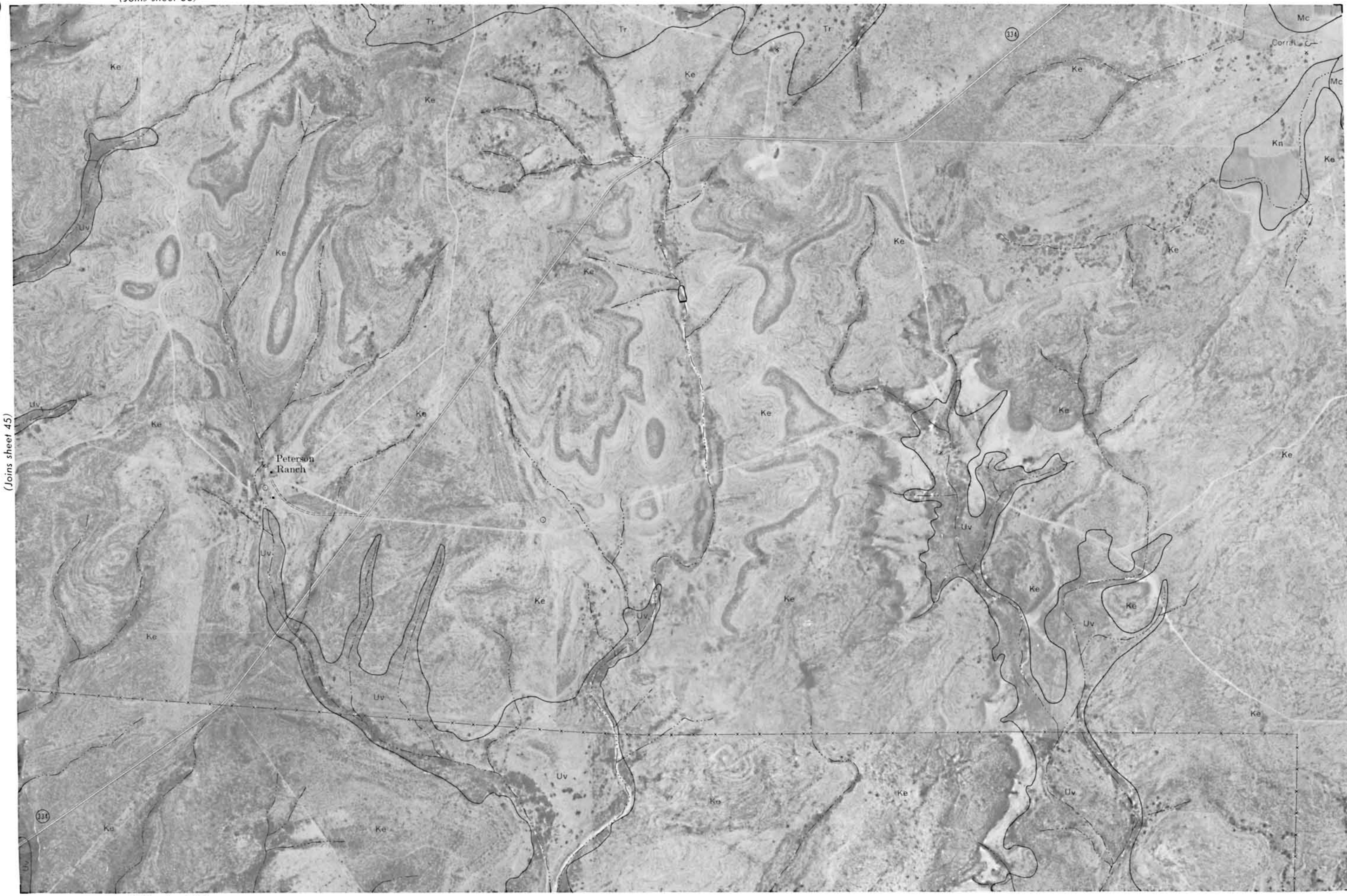

(Joins sheet 36)
N
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 52)
C.Belcher Ranch
Wardlow Brothers Ranch
Zinsmeister Ranch
Jones Ranch
Pinto Creek
Elm Creek
Kh
Uv
Pc
Ke
Fr
0
½
1 Mile
0
5000 Feet



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the Texas Agricultural Experiment Station

KINNEY COUNTY, TEXAS — SHEET NUMBER 46

(Joins sheet 38)

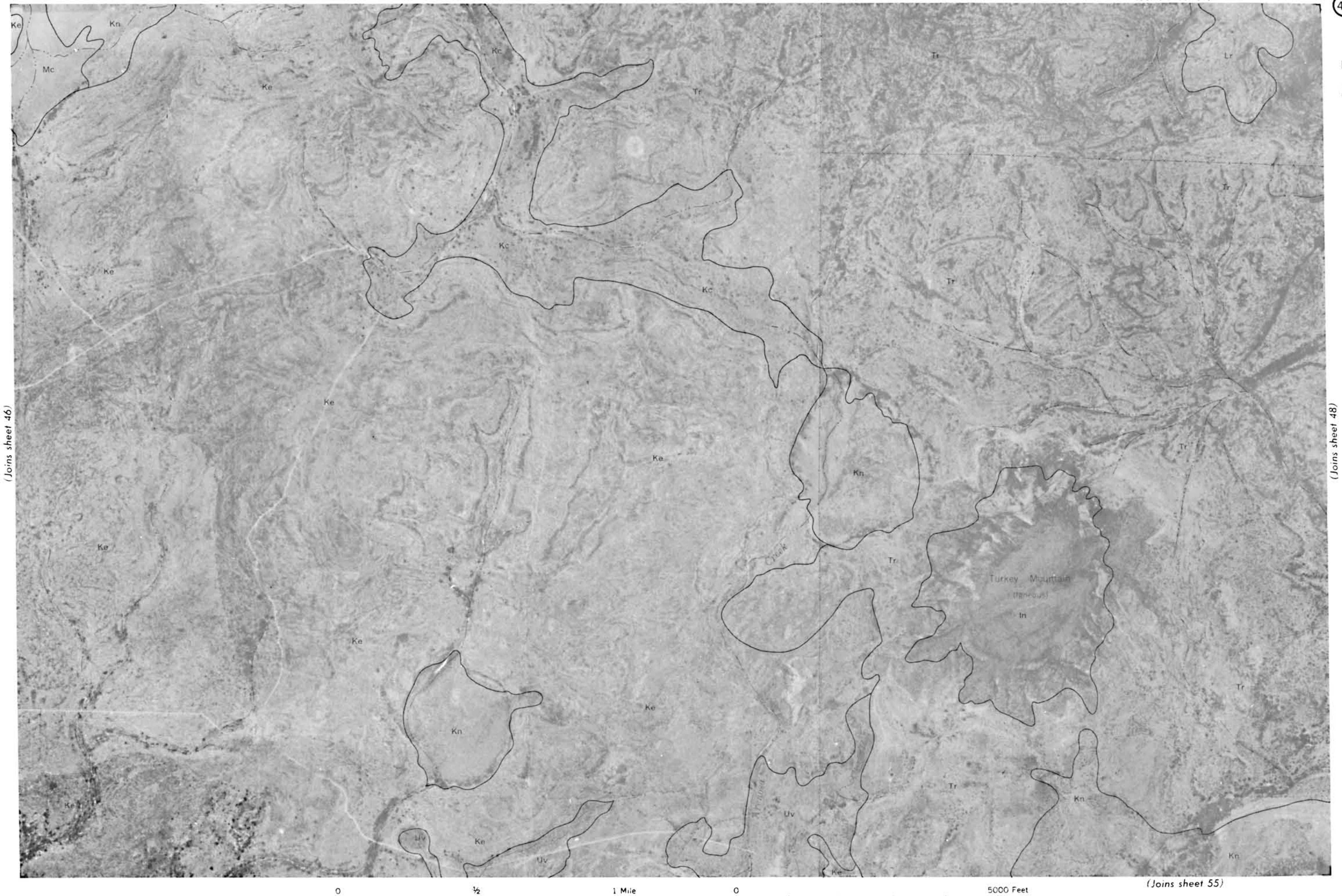


(Joins sheet 54)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 39)



(Joins sheet 46)

(Joins sheet 48)

(Joins sheet 55)

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station

48

N

(Joins sheet 40)

(Joins sheet 47)

(Joins sheet 56)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 41)

49

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(Joins inset, sheet 41)

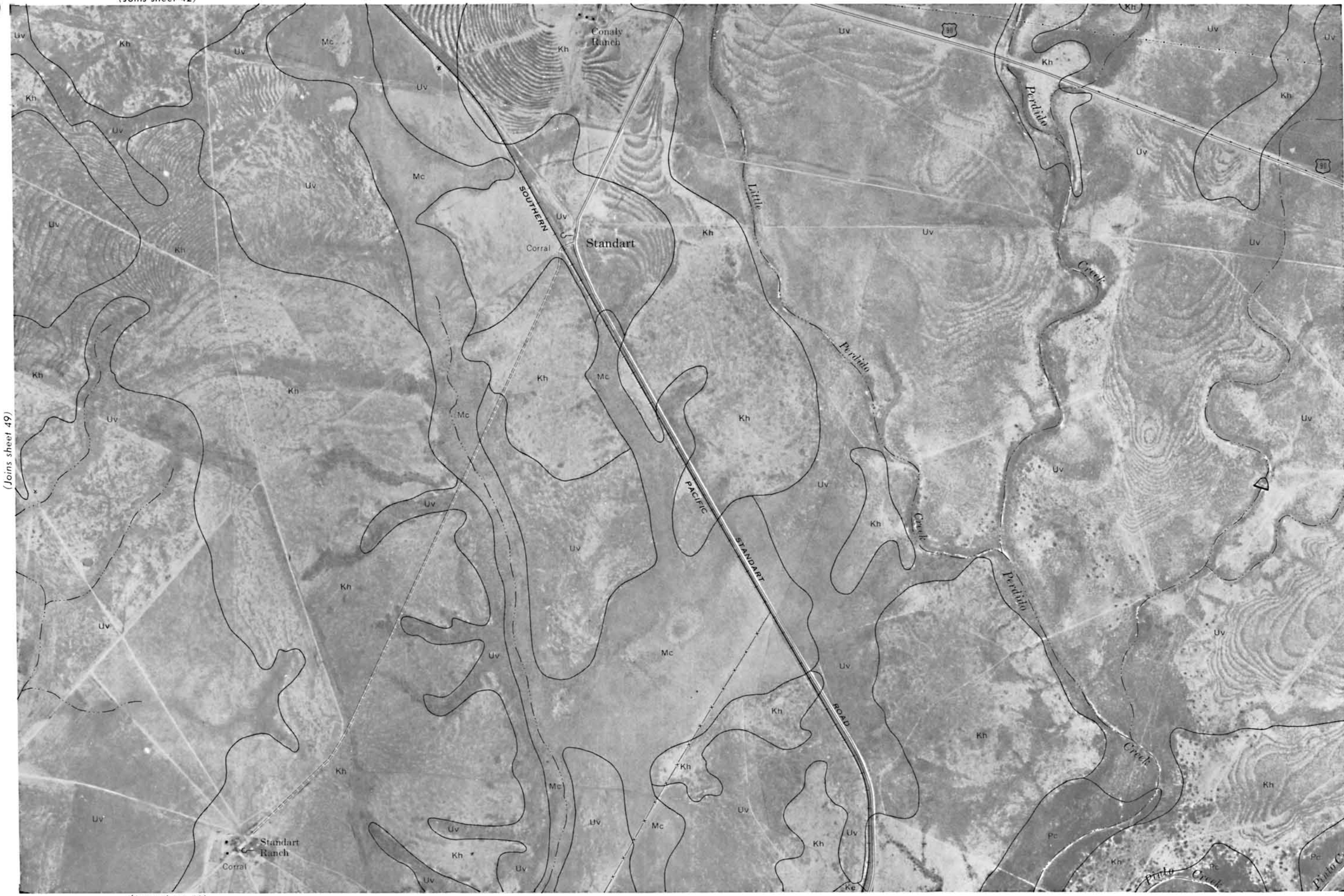
(Joins sheet 50)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 42)

(Joins sheet 49)



(Joins sheet 51)

(Joins sheet 59)

0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 51

(51)

(Joins sheet 43)

(Joins sheet 50)

(Joins sheet 52)

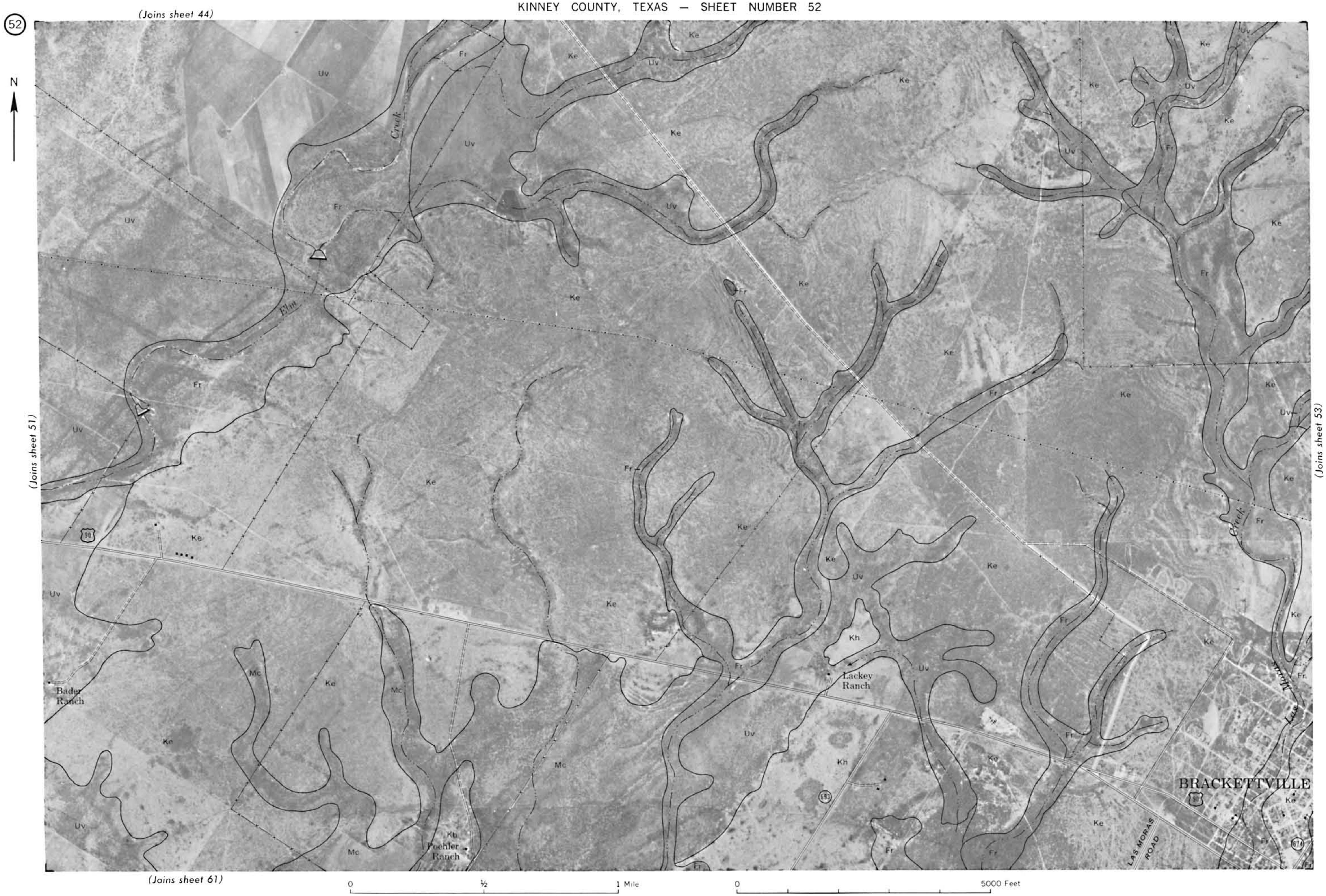
(Joins sheet 60)

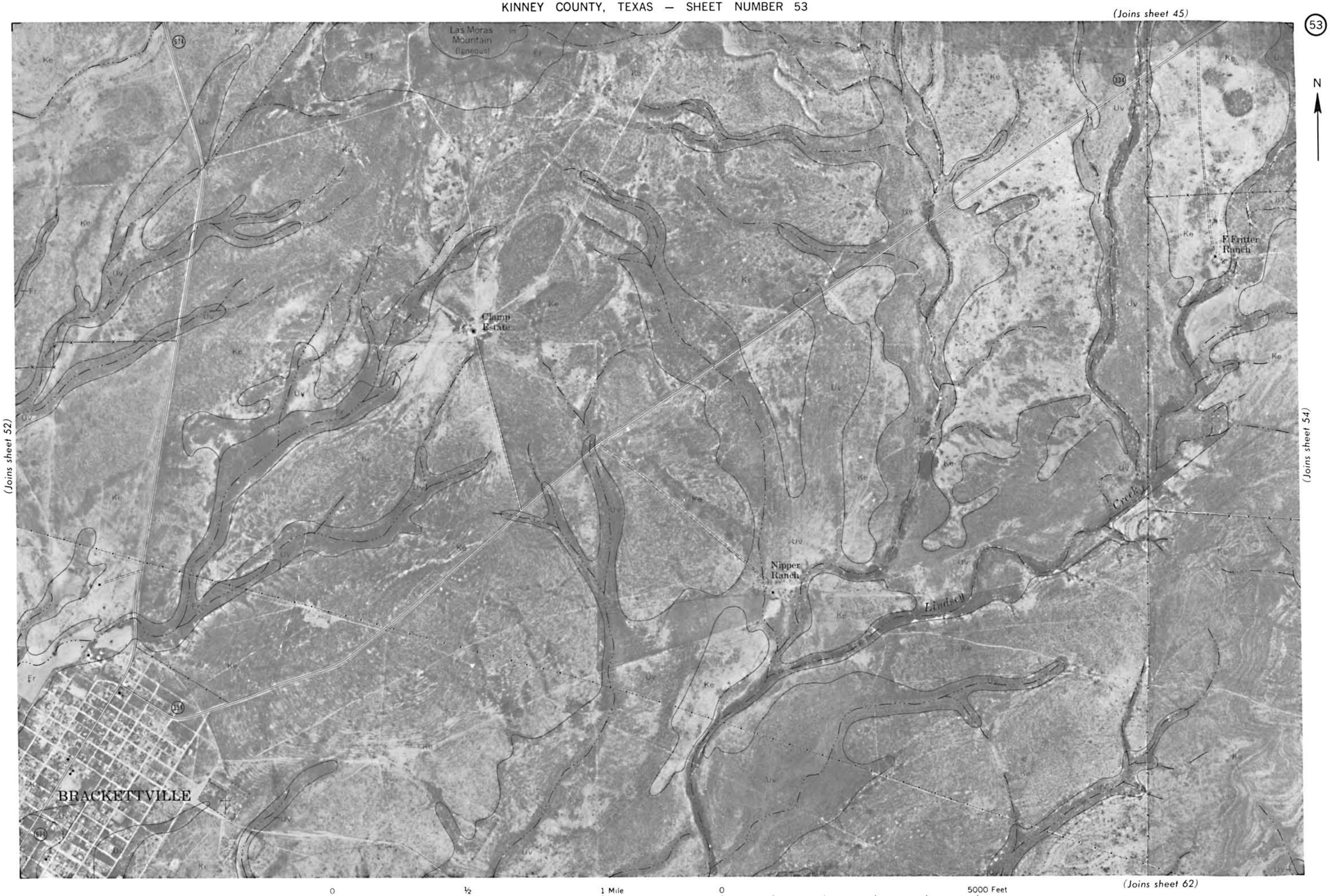
0 ½ 1 Mile

0 5000 Feet

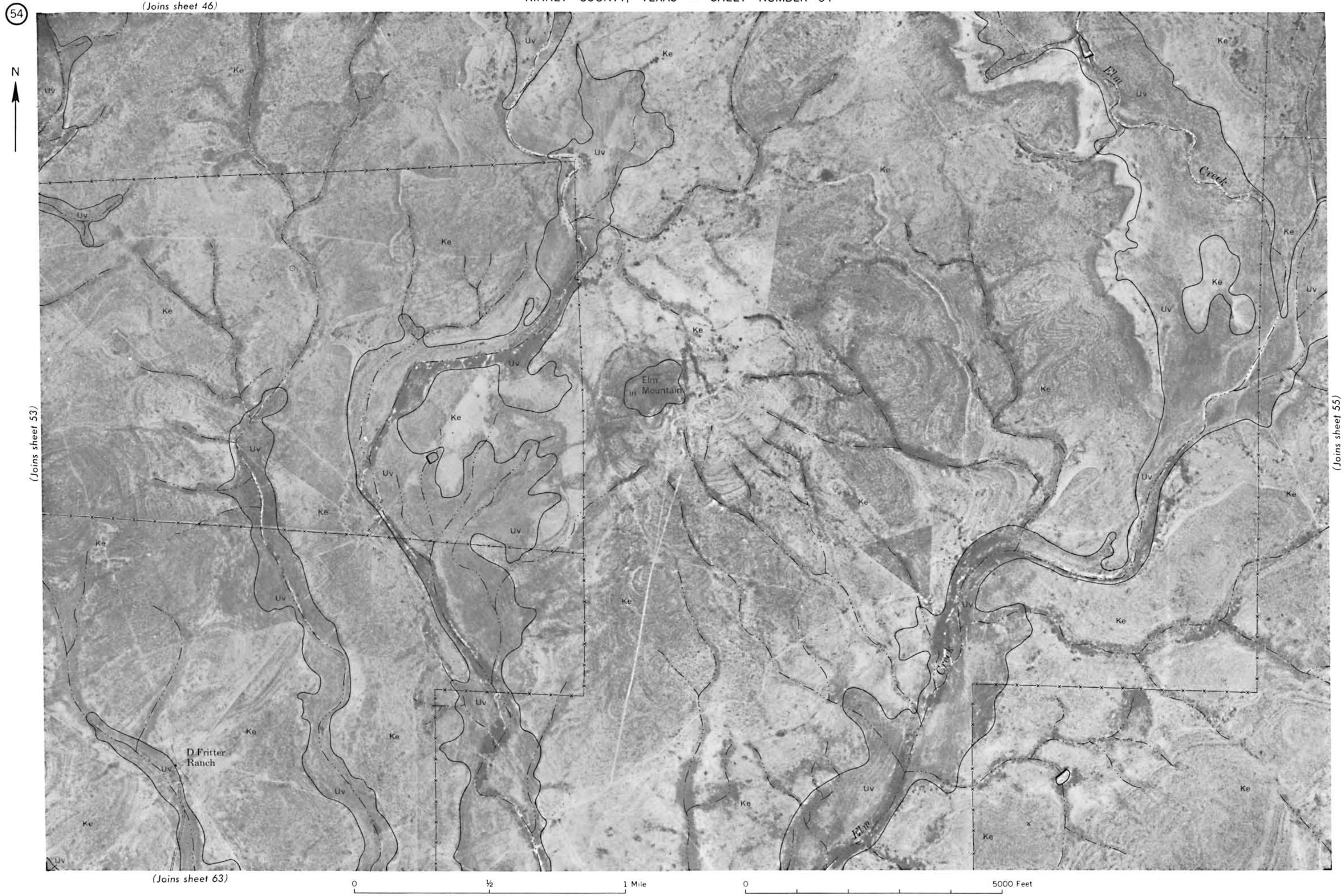
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the Texas Agricultural Experiment Station

KINNEY COUNTY, TEXAS — SHEET NUMBER 52





This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


54
(Joins sheet 46)
N
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 63)
Elm Mountain
Elm Creek
D Fritter Ranch
Ke
Uv
0
½
1 Mile
0
5000 Feet

(55)

(Joins sheet 47)

(Joins sheet 54)

(Joins sheet 56)

(Joins sheet 64)

0 ½ 1 Mile 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 56

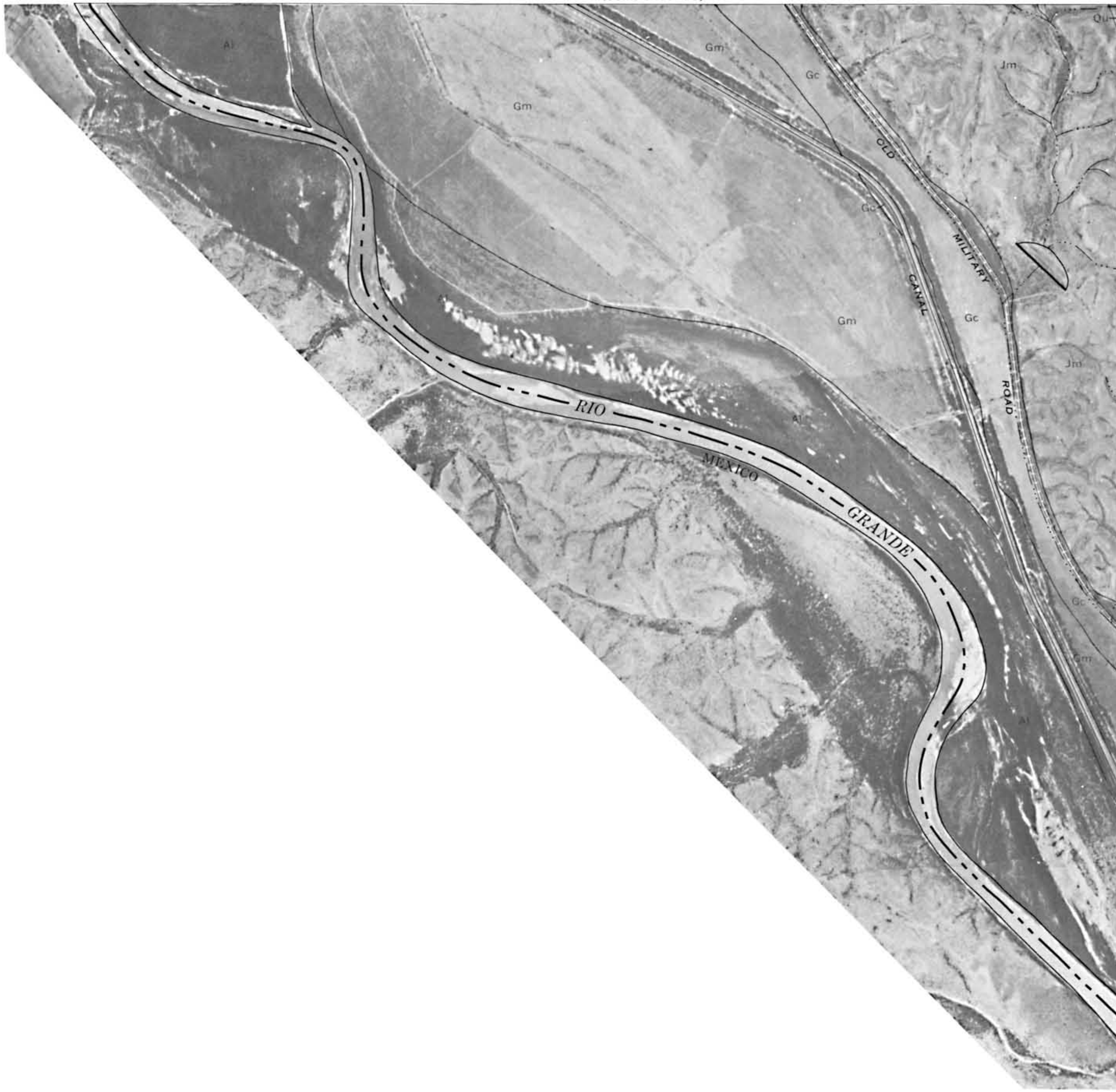
(Joins sheet 48)

(Joins sheet 55)

(Joins sheet 65)

0 ½ 1 Mile

0 5000 Feet



0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


58
(Joins sheet 49)
N
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 67)
Mud Creek
Pinto Creek
Ke
Uv
Ra
Kh
Fr
0
½
1 Mile
0
5000 Feet

(Joins sheet 50)

59

N

(Joins sheet 58)

(Joins sheet 60)

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 68)

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

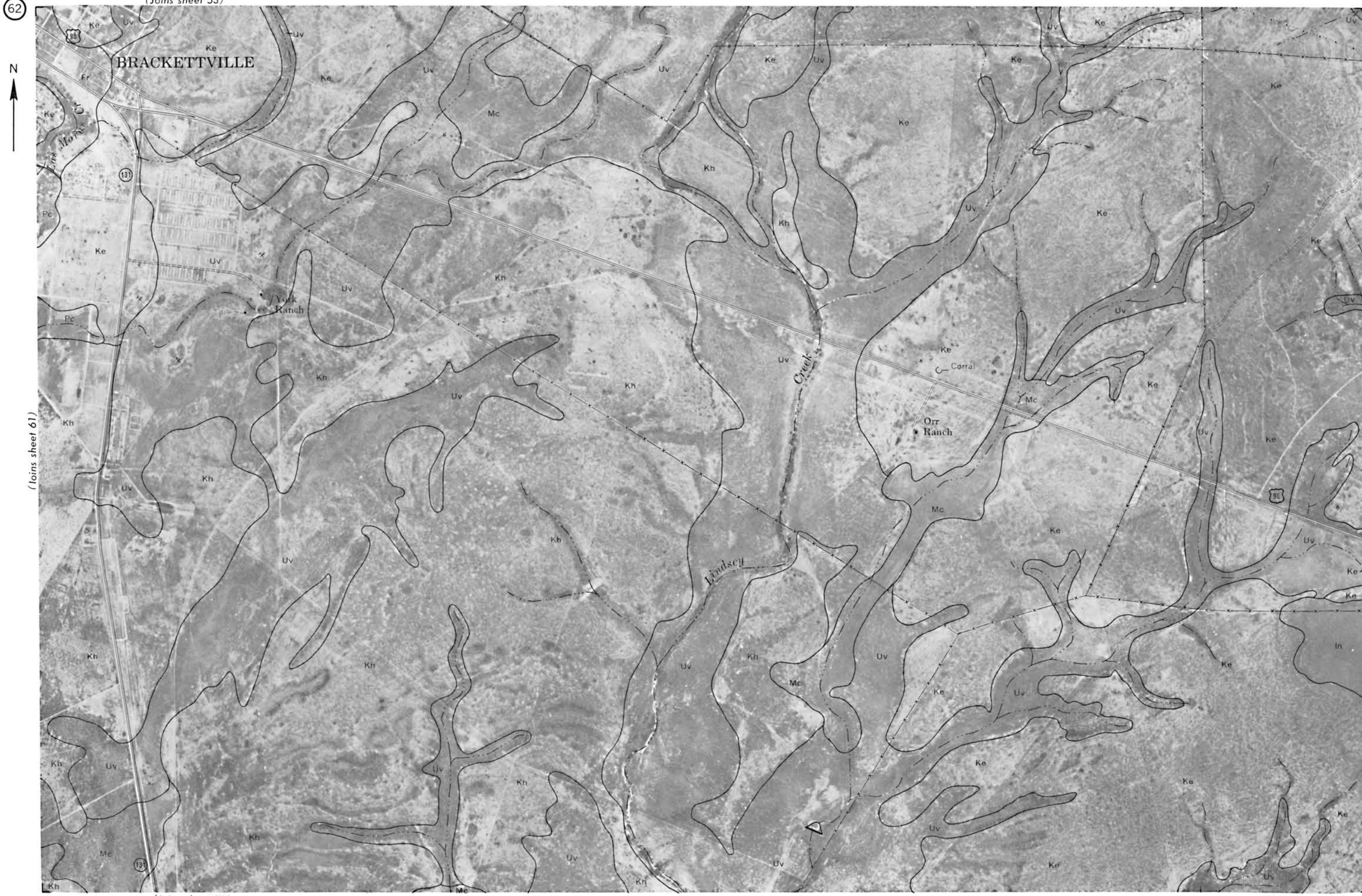
KINNEY COUNTY, TEXAS — SHEET NUMBER 60

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 62

62

(Joins sheet 53)



(Joins sheet 61)

(Joins sheet 63)

(Joins sheet 71)

0 ½ 1 Mile

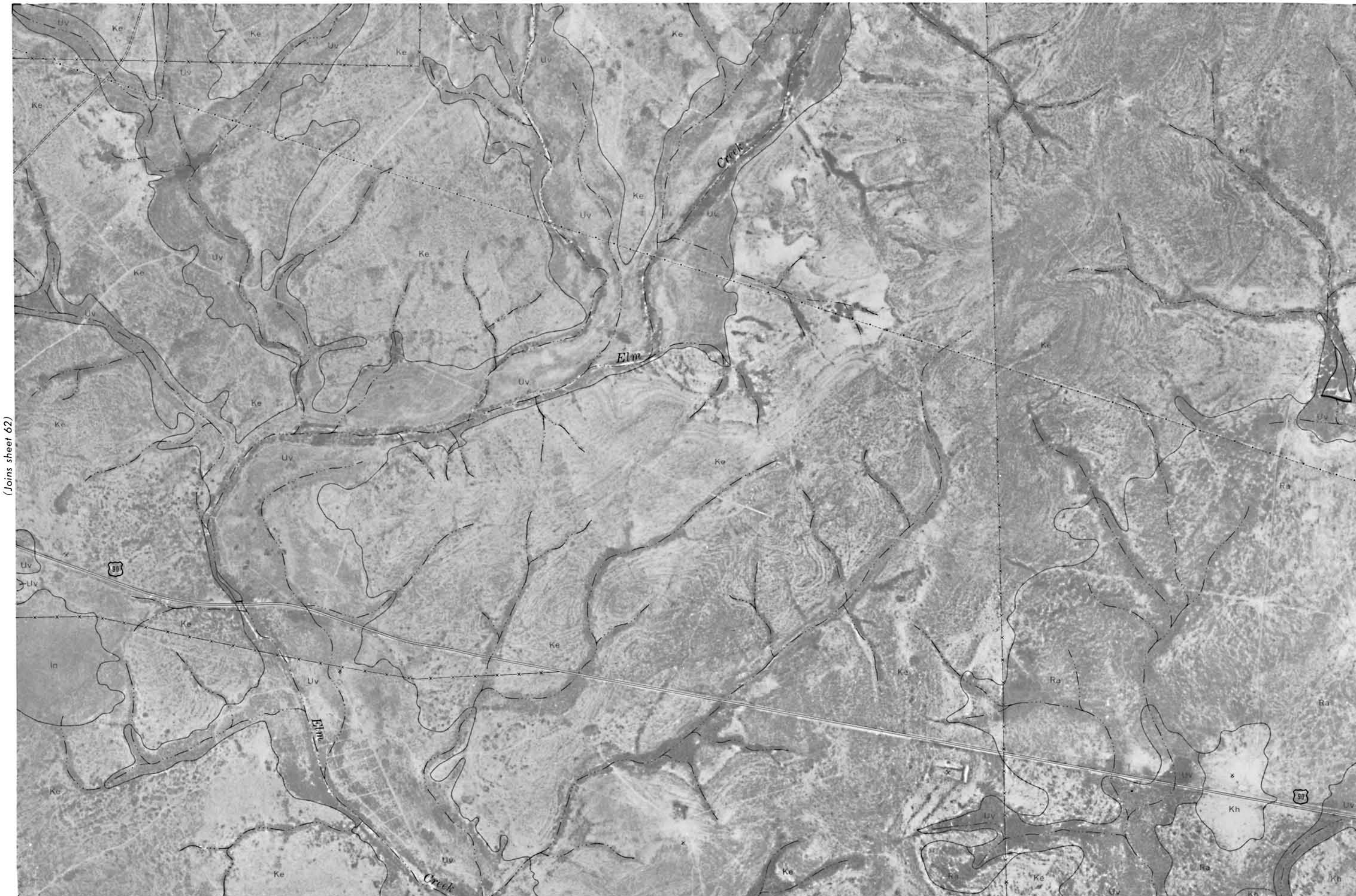
0 5000 Feet

(Joins sheet 54)

63

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(Joins sheet 62)



(Joins sheet 64)

(Joins sheet 72)

0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 64

KINNEY COUNTY, TEXAS — SHEET NUMBER 65

(Joins sheet 56)

65

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(Joins sheet 64)

(Joins sheet 74)

0 ½ 1 Mile

0 5000 Feet

(66)

KINNEY COUNTY, TEXAS — SHEET NUMBER 66

(Joins sheet 57)

N

(Joins sheet 67)

(Joins sheet 75)

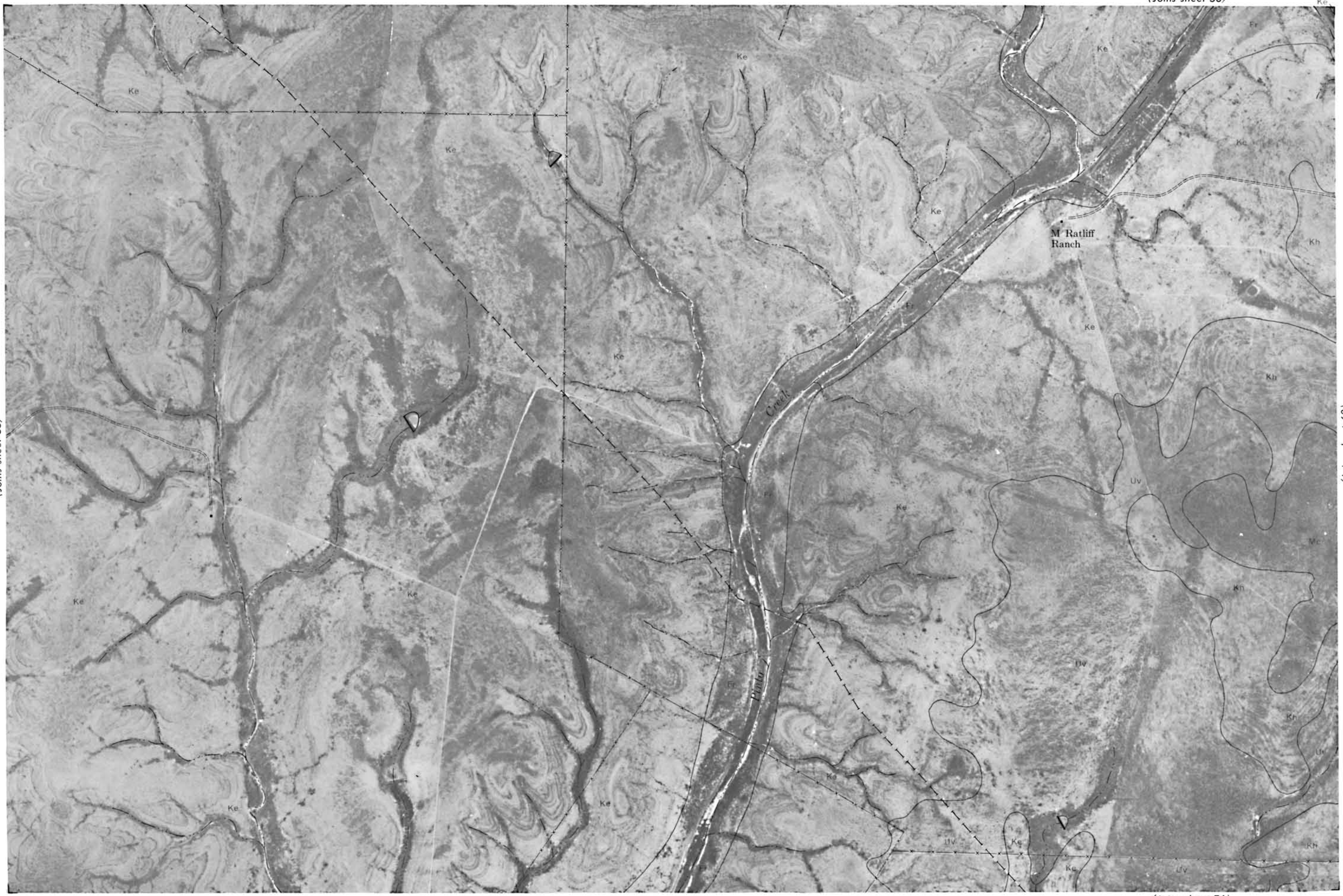
0 ½ 1 Mile

0 5000 Feet

(Joins sheet 58)

67

(Joins sheet 66)



(Joins sheet 68)

(Joins sheet 76)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

68

(Joins sheet 59)

(Joins sheet 67)

(Joins sheet 69)

(Joins sheet 77)

(Joins sheet 60)

(Joins sheet 68)

(Joins sheet 70)

(Joins sheet 78)

0 ½ 1 Mile 0 5000 Feet

N

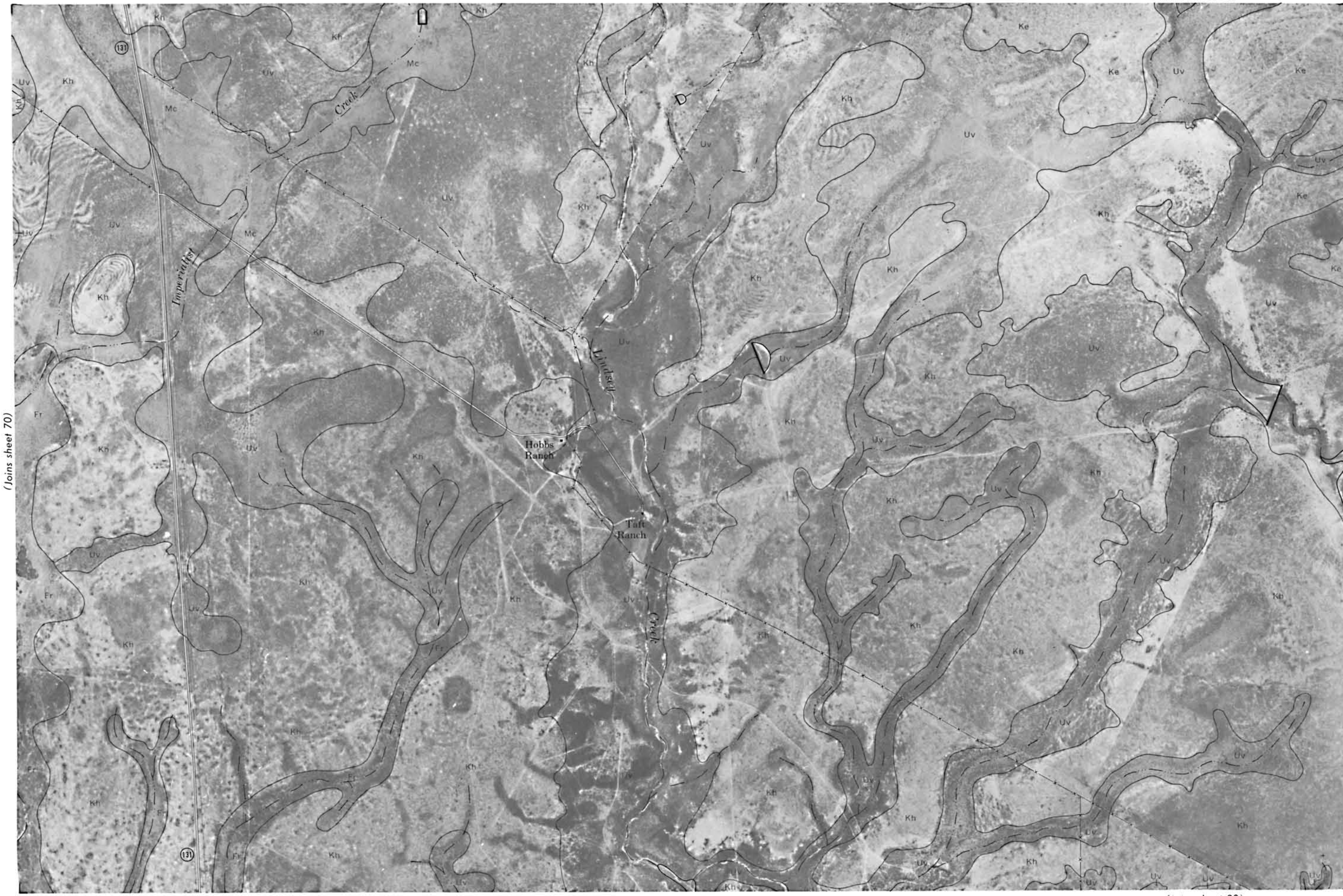
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


70
N
(Joins sheet 61)
(Joins sheet 69)
(Joins sheet 71)
(Joins sheet 79)
LAS MORAS ROAD
Las Moras Creek
Imperial Creek
Conoly Ranch
SOUTHERN PACIFIC
STANDART ROAD
Kh
Uv
Fr
Pc
Mc
0 ½ 1 Mile
0 5000 Feet

(Joins sheet 62)

71

N



(Joins sheet 70)

(Joins sheet 72)

(Joins sheet 80)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the Texas Agricultural Experiment Station.

72

(Joins sheet 63)

(Joins sheet 64)

73

N

(Joins sheet 72)

(Joins sheet 74)

(Joins sheet 82)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


74
(Joins sheet 65)
N
(Joins sheet 73)
(Joins sheet 83)
East Fork
Turkey Creek
West Fork Turkey Creek
SOUTHERN PACIFIC
White Ranch
UVALDE COUNTY
90
Ke
Uv
Kh
Lr
0 ½ 1 Mile
0 5000 Feet

(Joins sheet 66)

75

(Joins sheet 76)

(Joins sheet 57)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

76

(Joins sheet 67)

(Joins sheet 84)

0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 77

(Joins sheet 68)

77

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

(Joins sheet 76)

(Joins sheet 78)

(Joins sheet 85)

0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 78

N

(Joins sheet 69)

(Joins sheet 77)

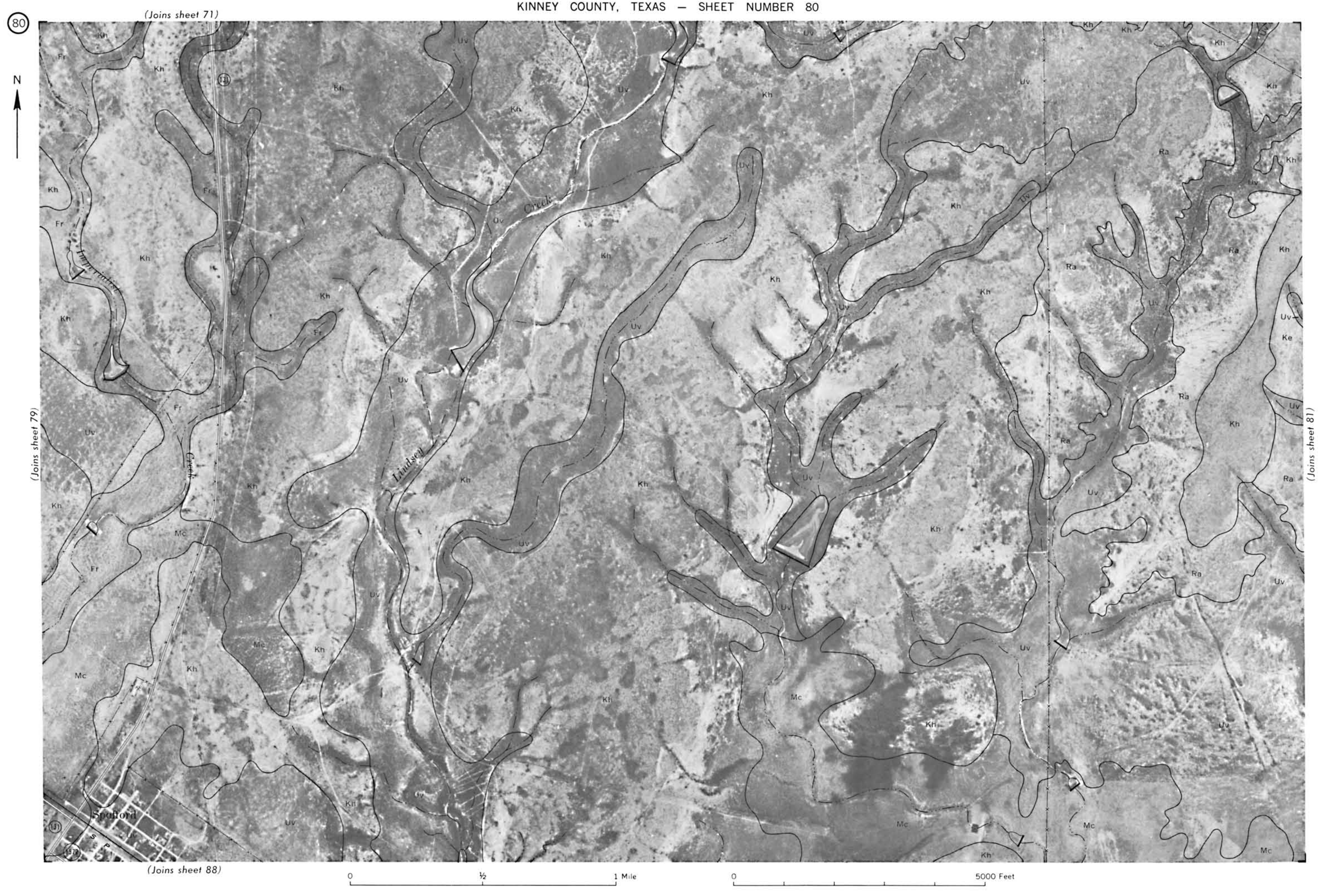
(Joins sheet 79)

(Joins sheet 86)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


80
(Joins sheet 71)
N
(Joins sheet 79)
(Joins sheet 81)
(Joins sheet 88)
Creek
Lindsey
Creek
Spofford
Kh
Uv
Fr
Mc
Ra
Ke
0
½
1 Mile
0
5000 Feet

(Joins sheet 72)

81

(Joins sheet 80)

(Joins sheet 82)

(Joins sheet 89)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


82
(Joins sheet 73)
(Joins sheet 81)
(Joins sheet 83)
(Joins sheet 90)
N
1572
ANACACHO MOUNTAINS
Beef Canyon
Mustang Canyon
Corral
Mitchell Ranch
Uv
Ra
Kh
Ke
Et
Ds
Lr
0
½
1 Mile
0
5000 Feet

(Joins sheet 74)

(Joins sheet 82)

(Joins sheet 91)

0 ½ 1 Mile

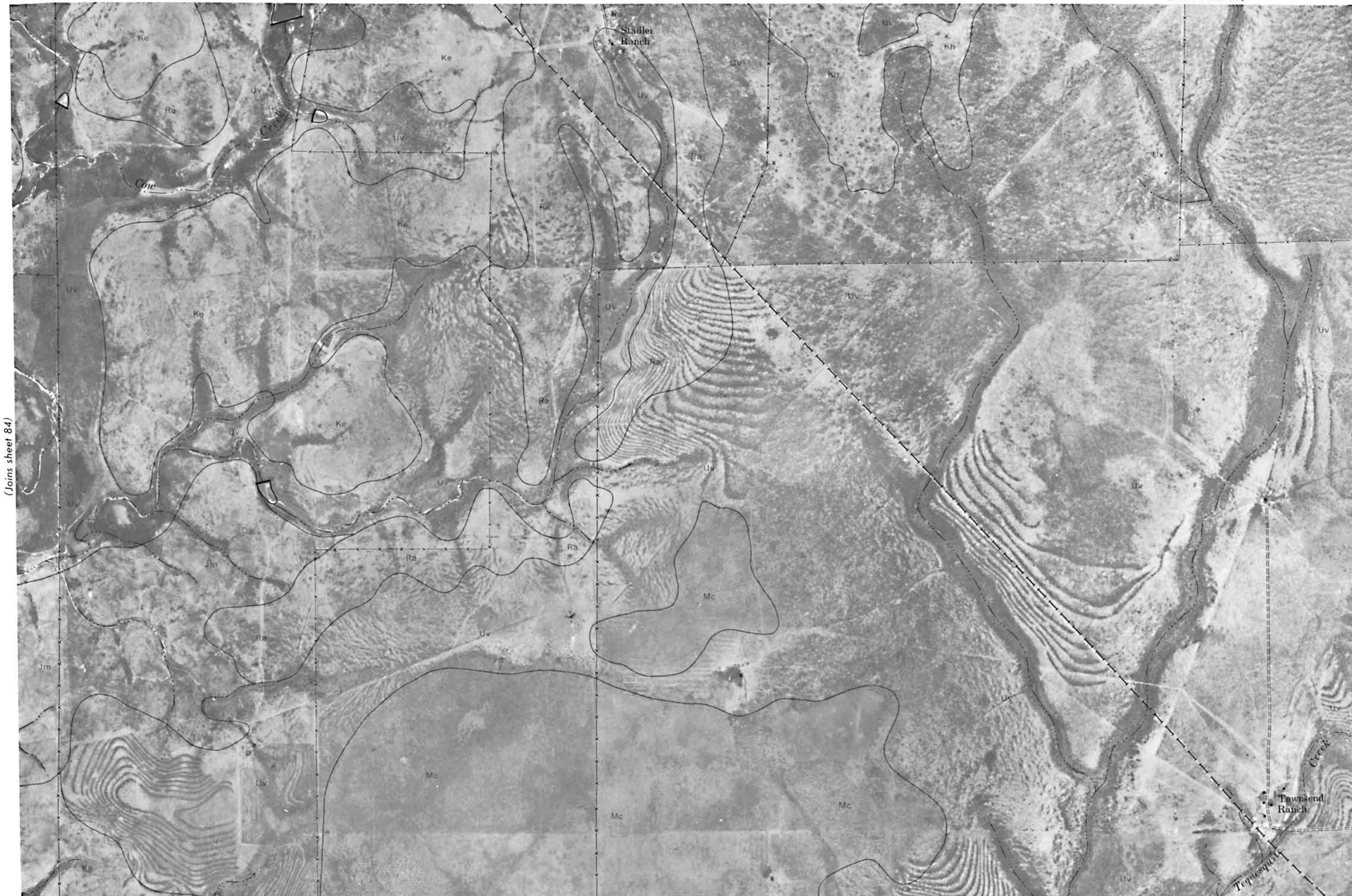
0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


84
(Joins sheet 76)
N
(Joins inset, sheet 57)
(Joins sheet 85)
(Joins sheet 92)
Qu
Jm
Fr
Ke
Uv
Ra
Kn
Gc
Gm
Al
Pinto
Creek
Cow
OLD
MILITARY
ROAD
CANAL
RIO
GRANDE
MEXICO
0
½
1 Mile
5000 Feet

(Joins sheet 77)

(Joins sheet 84)



(Joins sheet 86)

(Joins sheet 93)

0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 86

(Joins sheet 78)

(Joins sheet 94)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 88

(Joins sheet 80)

N

(Joins sheet 87)

(Joins sheet 89)

(Joins sheet 96)

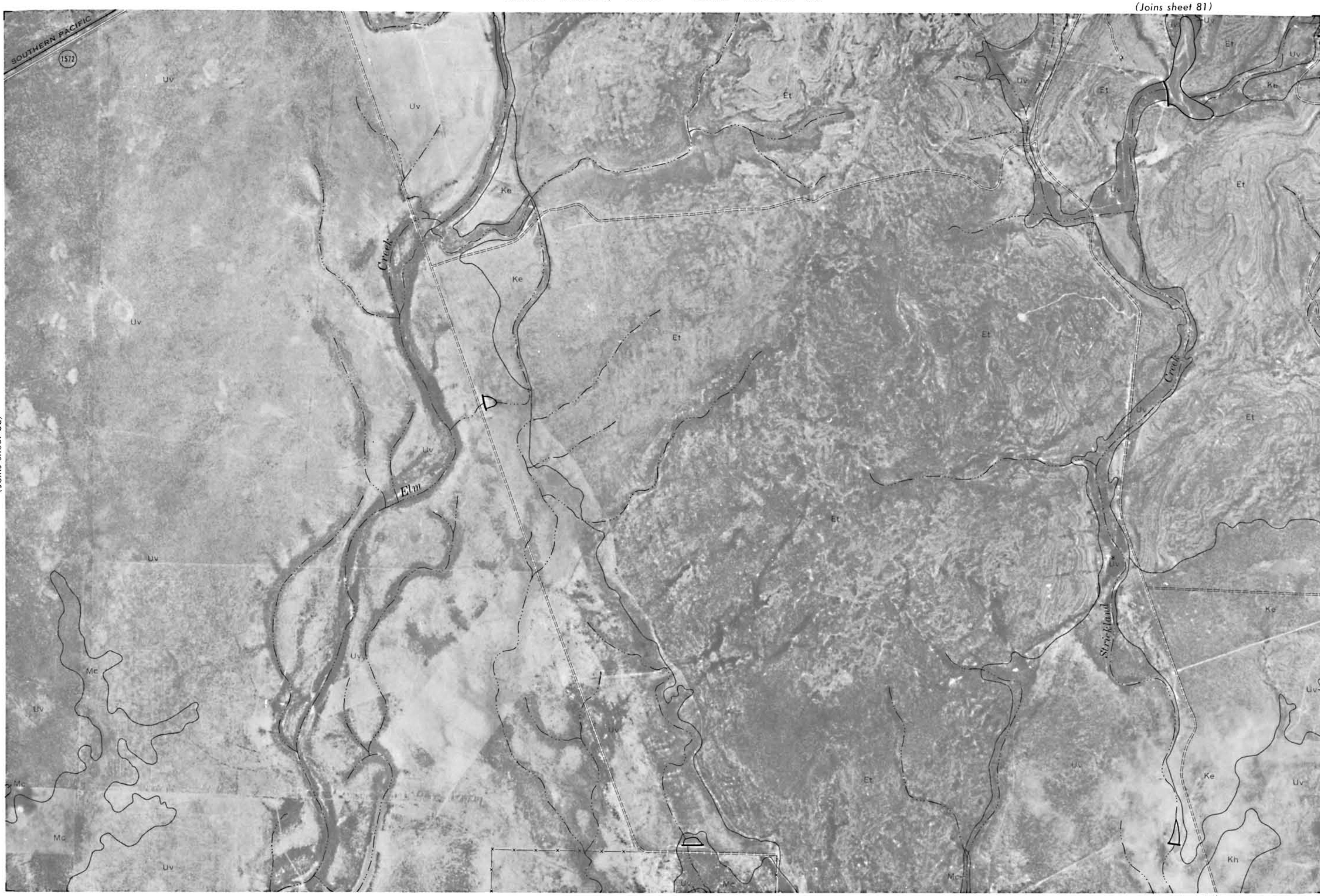
0 ½ 1 Mile

0 5000 Feet

(Joins sheet 81)

(89)

(Joins sheet 88)



(Joins sheet 90)

(Joins sheet 97)

0 ½ 1 Mile

0 5000 Feet

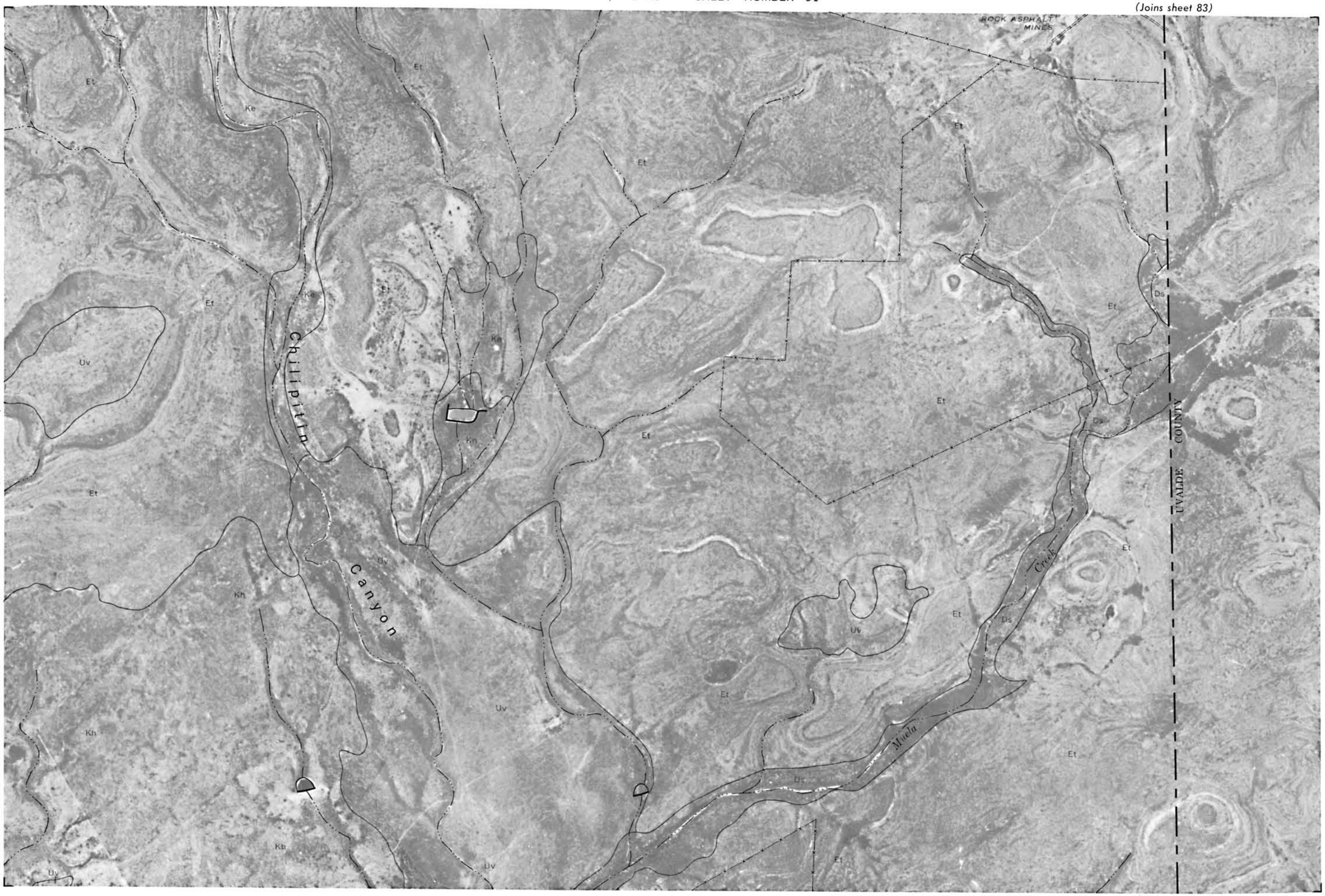
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


90
N
(Joins sheet 82)
(Joins sheet 89)
(Joins sheet 91)
(Joins sheet 98)
Beef Canyon
Mustang Canyon
Strickland Creek
Corral
Et
Ke
Ds
Uv
Kh
Mc
0
½
1 Mile
0
5000 Feet

(Joins sheet 83)

91

(Joins sheet 90)



(Joins sheet 99)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 92

(Joins sheet 85)

93

(Joins sheet 92)

(Joins sheet 94)

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

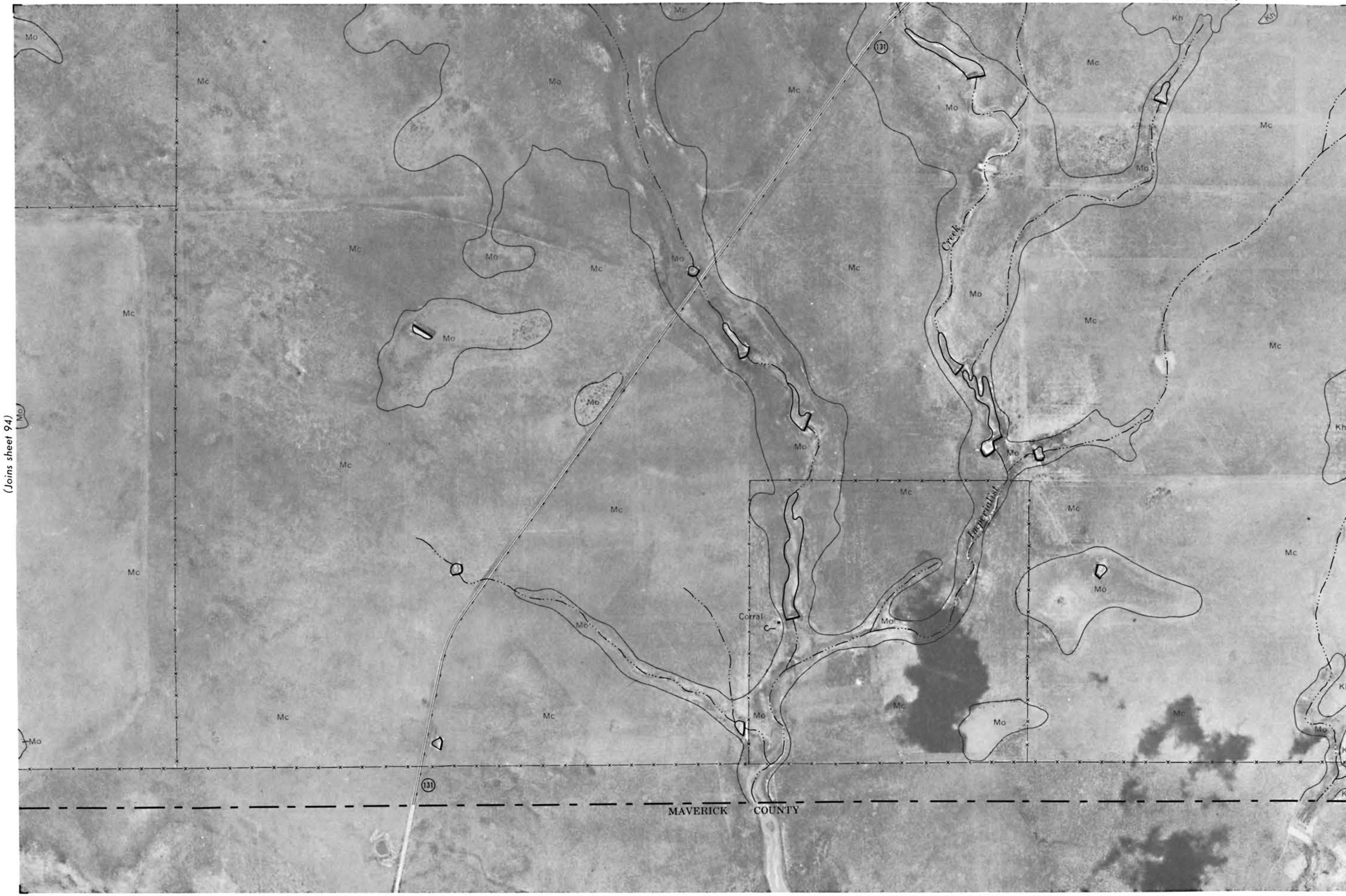
0 ½ 1 Mile

0 5000 Feet

KINNEY COUNTY, TEXAS — SHEET NUMBER 94

(Joins sheet 87)

(Joins sheet 94)



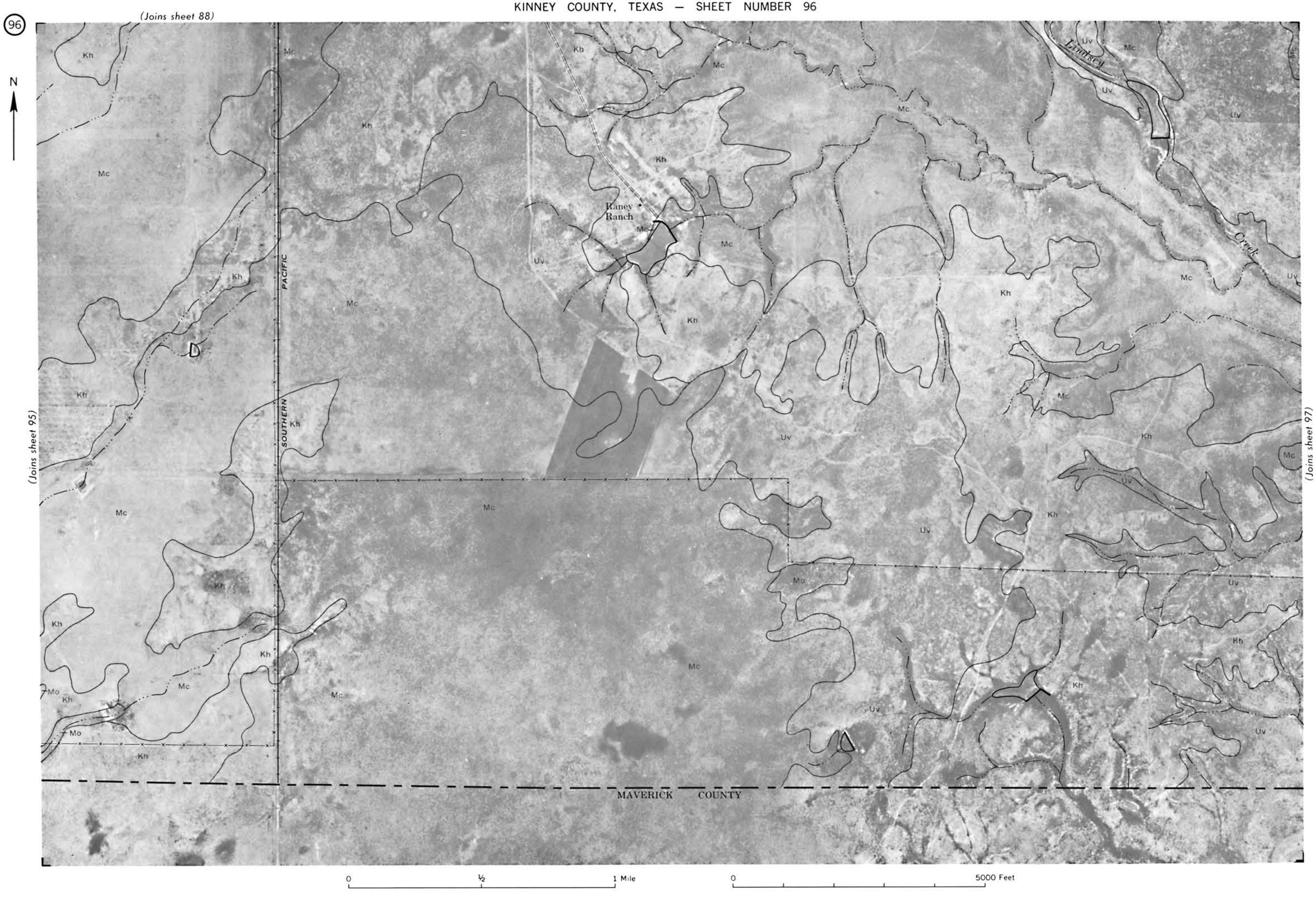
(Joins sheet 96)

0 ½ 1 Mile

0 5000 Feet

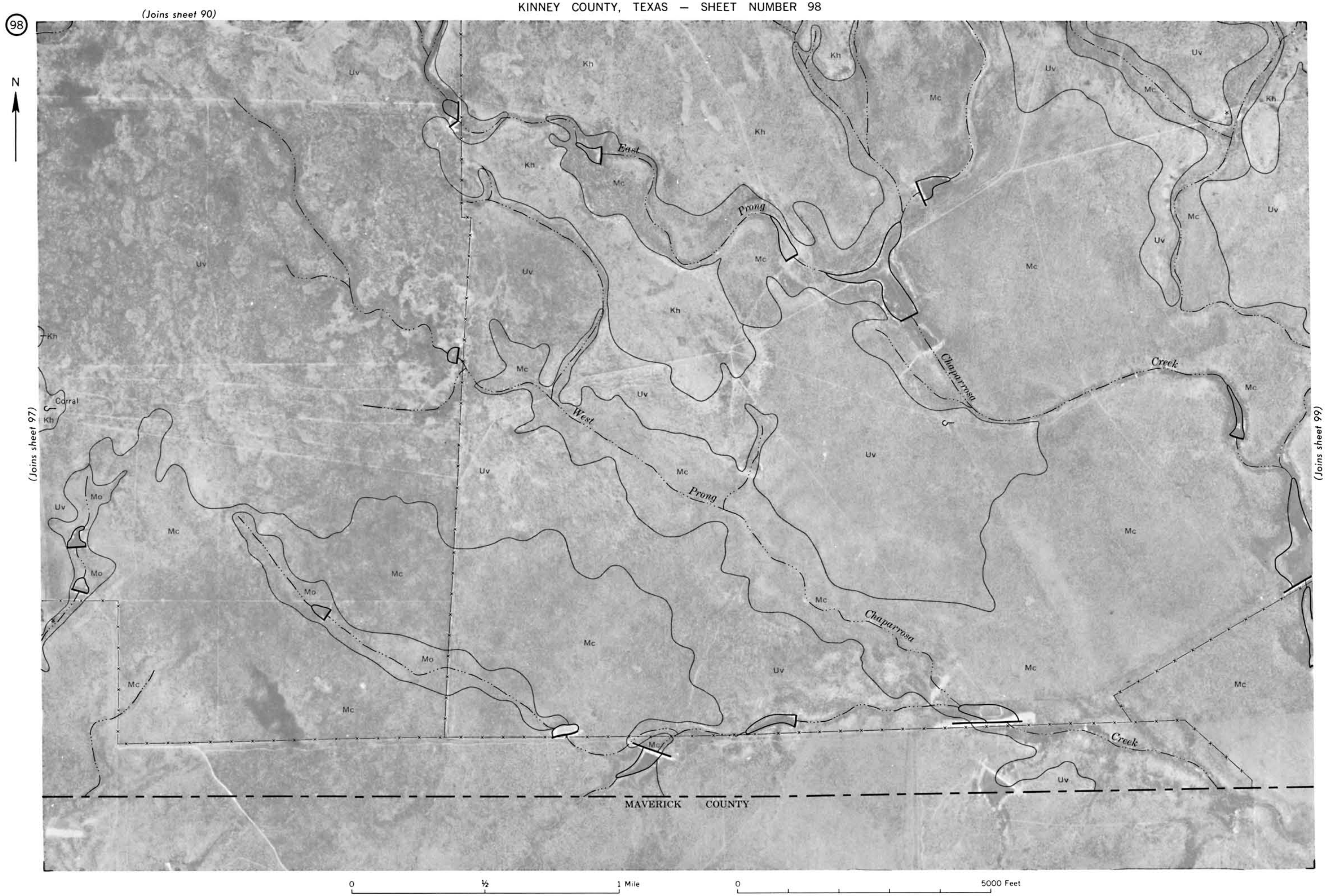
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

KINNEY COUNTY, TEXAS — SHEET NUMBER 96



KINNEY COUNTY, TEXAS — SHEET NUMBER 97

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.


98
(Joins sheet 90)
N
(Joins sheet 97)
(Joins sheet 99)
East
Prong
West
Prong
Chaparrosa
Creek
Chaparrosa
Creek
Corral
MAVERICK COUNTY
Uv
Kh
Mc
Mo
0
½
1 Mile
0
5000 Feet

(Joins sheet 91)

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.